BIER'S TEXTBOOK OF HYPERÆMIA

AS APPLIED IN MEDICINE AND SURGERY

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AS APPLIED IN MEDICINE AND SURGERY

BY

PROFESSOR DR. AUGUST BIER

OF BERLIN

ONLY AUTHORIZED TRANSLATION FROM THE SIXTH GERMAN REVISED EDITION

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TO

PROFESSOR CARL BECK, M.D.

OF NEW YORK

THIS TRANSLATION IS DEDICATED

BY THE TRANSLATOR

AS A TOKEN OF APPRECIATION OF HIS SERVICES

RENDERED THE SCIENCE OF SURGERY

AUTHOR'S FOREWORD TO THE SIXTH GERMAN EDITION

The chapter on the treatment of acute inflammation and suppuration with congestion hyperæmia has been greatly changed and enlarged. Of late a great deal of literature on this subject has appeared. My observations, with slight exceptions, have been confirmed, and the great value of congestion hyperæmia for the treatment of these diseases has been generally recognized. Only a few individual opponents consider this form of hyperæmia in acute inflammation superfluous or dangerous and obnoxious. All these observations had to be taken into consideration, and the objections of the opponents subjected to detailed discussion.

Chapters have been added on the treatment of keloids, tendo-vaginitis crepitans, and diseases of the skin. I have made these chapters as short as possible to prevent too great an increase in the size of the volume. Finally, an index has been added.

TRANSLATOR'S PREFACE

In presenting to the English-speaking members of the medical profession the opportunity to become familiar with the latest monograph of Professor August Bier on his method of systematically treating a large variety of diseases with artificially produced hyperæmia, it is believed that a distinct service has been rendered the cause of scientific medicine.

When Bier first gave to the medical public his "Hyperämie als Heilmittel," little was known of his epoch-making work in England and America.

Abstracts from original German publications on the subject have appeared in the better periodicals, but the great majority of practitioners either paid little attention to it or did not make use of the method because of lack of familiarity with the technique.

Of late, however, there has been quite a change, for whatever opinion one may have on the merits of the therapeutic system as such, it is generally conceded that Bier's investigations may yet compel us to change our present conception of inflammation—a circumstance which forces every progressive medical man to become conversant with the doctrines promulgated by the path-finding German surgeon.

From a purely practical point of view, Bier's method of treatment with artificially produced hyperæmia is hailed by some as a veritable panacea and decried by others. In medicine, theories must be based on facts. The most logical deductions totter if not supported by actual clinical experience. Whether or not practice bears out Bier's claims, time will tell, for until now the bulk of practitioners have been unable to make use of the remedy in their daily work, for reasons above given.

But whatever opinion shall prevail, this much is certain : that Bier's work has stirred the minds of able surgeons as no other problem since the discovery of the circulation of the blood, the introduction of antisepsis, and the employment of antitoxin, and that in spite of much ridicule and opposition.

To remain ignorant of such a work means to ignore not only an interesting theoretic problem, but a remedy which has already proved a blessing to countless sufferers from at least one class of affections.

Owing to the importance of the subject, an attempt has been made to offer an unabridged, faithful translation of the original.

To avoid possible confusion, it must be remarked that the nomenclature adopted by the translator is not identical with that frequently met with in English publications.

Thus, Bier's " Stauungs-hyperämie " has been described as " induced," " constriction," and " damming hyperæmia," but after due and deliberate consideration the word " congestion " has been selected as best representing an English equivalent.

Literally translated, the word " Stauung " means " damming," or " stasis." But such a condition is not aimed at by the author, as can be easily seen from a perusal of the subsequent pages. What he does aim at is a " flooding " with blood of the parts to be treated, and at the same time maintenance of the circulation—in other words, a true congestion.

The circumstance that this condition is produced by constriction with a suitable elastic bandage or piece of rubber tubing is not sufficient reason to designate the resultant hyperæmia as a " constriction hyperæmia," for it is not the means, but the result, that is of bearing here.

Not infrequently we see congestion hyperæmia referred to as " induced hyperæmia." This, too, is not free from objections, because the word " induced " is not descriptive enough, and equally applicable to anything artificially produced, hence also to the active hyperæmia produced by hot air, to the mixed hyperæmia obtained through diverse suction appliances.

An apology is due for the employment of such a hybrid

term as "hyperæmize," a word selected by the translator for the sake of brevity.

Finally, the bandage for the production of congestion hyperæmia is termed "constrictor" and "congestion bandage" in the following pages, both terms being regarded as synonymous.

The translator deems it a pleasant duty to acknowledge his indebtedness to Dr. R. W. Felkin for revision of the hastily prepared manuscript, and to the publishers, Messrs. Rebman Ltd., for many valuable suggestions and for the liberality displayed in the mechanical make-up of the work.

GUSTAVUS M. BLECH.

CHICAGO,
March, 1909.

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BIER'S TEXTBOOK OF HYPERÆMIA

INTRODUCTORY

It is not so very long ago that not only theologians and a large number of philosophers and naturalists, but also many physicians, thought teleologically. In all processes which they observed in man during health and disease, they asked themselves: Why do they occur, and of what use are they to the organism? This teleologic conception was at all times deeply rooted in the minds of the people. Proof for this is found in the ancient idea that disease is a fight of the body against an intruded enemy, which, depending on the victory of the former or latter, terminates in recovery or death, and also in the view held by laymen even to this day, that fever, inflammation, suppuration, diaphoresis, expectoration, and diarrhœa, serve to remove from the body "noxious and impure matter."

I will endeavour to show that a teleologic standpoint is not only rational and justified, but even essential for the observation of things in animated nature. However, these teleologists overreach their mark. To begin with, they committed an error in defending the so-called anthropocentric teleology. Man was put in the centre of the universe, and for his personal benefit everything has been created. It is for him only that the sun shines and the rain falls; animals and plants have been created to serve him as food; for his delight only Nature has been made so beautiful and magnifis

cent. Justly this kind of teleology became the subject of ridicule when it went so far as to explain the ripening of cherries in summer "in order that man should have his refreshment in the warm season." Even the older philosophy opposed this vehemently. But it was principally Darwin's teaching which dealt it the death-blow. Darwin did not lift man from the rest of Nature to put him over it, but placed him within it, and permitted him to be only one of the innumerable phenomena of Nature, of whom one did not even know whether he would not be replaced by something better and more perfect in the course of tremendous spaces of time.

These older teleologists again erred, in that they did not recognize the purposiveness in Nature as a simple matter of fact, but established it as an explanation for all possible phenomena. They did not trouble themselves to inquire into the deeper causes of things, but simply said: This is so and not otherwise, this becomes so and not otherwise, because so it is rational. Naturally, such a system is most defective, and apt to obstruct scientific progress. It is, therefore, not to be wondered at that, with the application of exact, scientific inquiry in medicine, these doctrines became ill-reputed. And then it happened as it usually does when reaction follows collapsing, axiomatic views: with the decadence of the doctrine the good kernel too was dropped, and even to-day the practical physician who confesses to hold such teleologic views as we shall discuss is in danger of being called obsolete by such of his professional colleagues who consider themselves exact and scientific investigators.

If these people, however, were a little more familiar with biology, which must be considered the foundation of practical medicine, if the latter is to rank as a science, it is they who would find themselves to be the back numbers. To be sure, biology ignores the great fundamental problem, whether the universe and man has an object—a problem which, as long as thinking man will exist, stirs and will stir the mind, and which undoubtedly never will be solved—and leaves it to the philosopher and theologian. Though it was Darwin's teaching, which to-day dominates modern biology, that most effectively did away with the naïve anthropocentric tele-

ology, and though a large number of Darwinists[1] at first declined to entertain each and every teleologic conception, they soon became converted, and acknowledged that their idea lacked logic. Because, after all, the very nature of their teaching demands of their followers to be convinced teleologists in regard to the individual organism and the species, and that even of those who otherwise deny purpose in Nature, and who declare that all phenomena in Nature—including man—are but consequences of certain forces of Nature. For only a rationally constructed organism, adapted in every direction to the external conditions, can maintain the struggle for existence, while Nature itself removes everything irrational.

A large number of Darwin's strict adherents have expressed themselves thus, and have acknowledged themselves as teleologists by conviction. Some,[2] overreaching their mark, even asserted that it was Darwin's teaching which first brought to light and rendered comprehensible this limitation of purposiveness to animated phenomena of Nature. However, naturalists and philosophers of entirely different schools have thought similarly. Thus,

[1] Sachs ("Vorlesungen über Pflanzenphysiologie," Leipsic, 1882, p. 14) says these words, which even our medical antiteleologists may take to heart: "I would like to express myself on another point: it concerns the word 'purposiveness,' a word which many a fanatic of the theory of descent would, if possible, entirely banish from language. But because the purposiveness in the arrangement of the organisms has been formerly ascribed to other causes than now is no reason to rob our language of a meaning expression; for we understand by the expression, 'This or that arrangement in an organism is purposive,' nothing more but that it contributes to its ability of existence. It is evident that all the peculiarities of an organism must necessarily be so instituted that they cannot question its existence—at least, under conditions of life natural to it. 'Purposive' therefore, generally speaking, means as much as capable of existence, and it would be foolish even to waste a word as to whether or not the word may be used in this sense. It may also be regarded as devoid of scientific merit when it is asserted of any organic arrangement that it is purposive, or that it contributes to the ability of existence, for this is self-evident. On the other hand, it is at times important and meritorious to demonstrate how and under what modalities an arrangement of an organism is purposive, in what manner it contributes with other arrangements to the capability of existence of a certain organism. On the whole, physiology is essentially occupied with such proofs."

In the second edition these words are omitted, probably because in the meantime they have become self-evident to every botanist, and therefore superfluous.

[2] Compare Sprengel, "Zweckmässigkeit und Anpassung," Academic Oration, Giessen, 1898; and Ziegler, "Über den derzeitigen Stand der Darwin'schen Lehre," Jena, 1902.

Kant, in his "Criticism of Teleologic Judgment," discusses the "inner" purposiveness of the organisms, while strongly opposing the anthropocentric and "outer" teleology. His teleology, like that of Darwin, is free from the transcendental, for "the manner of mechanical explanation is not excluded by the teleologic, as if they contradicted each other."

Even among medical men the pure naturalists, anatomists, and physiologists, unreservedly acknowledge man's "inner purposiveness" of Kant and of the Darwinists. Each anatomist when discovering a new part, each physiologist when unearthing a new activity in the body, asks himself: Why is it there, and of what use is it to the organism? And he who would think otherwise would justly be considered a peculiar crank. The few remaining embryological data of the normal man which cannot be placed in the category of purposiveness prove nothing against the validity of this general rule.

Things are apparently different and more complicated in practical medicine, which concerns itself with the diseased body and its cure. The single fact that the body is very frequently attacked by disease, and that it is able, without the aid of a physician or artificial means, to effect a more or less perfect cure of the majority of diseases, should convince the physician of the presence of rational, natural healing processes. It is evident that this ability, because it leads to a cure of the disease for the welfare of man, can have but the character of inner purposiveness.

It is clear to everyone that the body, under many obnoxious influences, immediately resorts to rational means in order to remove them. No one will doubt that the violent cough which expels a foreign body lodged in the larynx, the intense vomiting which ejects caustic acids and alkalis, the profuse effusion of tears, and the lively spasm of the eyelids removing irritating bodies lodged in the eye, are highly rational arrangements. And yet these means of rescue, as represented by a violent attack of coughing and terrible vomiting, are so disagreeable to the injured man, and look so threatening in character, that the naïve observer, were he ignorant of the real injury, would look upon them as the real disease, whereas in reality they mean a warding off of the evil.

In those cases the size of the injurious agent makes it easily perceptible to our senses, and thus protects us against coming to so fatal and false a conclusion. This was not always the case when the injurious agent is so small and hidden that it could not be perceived at all or only through a microscope, as in the infectious diseases. Even to-day the majority of medical practitioners look upon the fever and inflammation which follow certain infections as promptly as a cough does when a foreign body becomes lodged in the larynx, as something obnoxious which must be combated, and it is not so very long ago that, with few exceptions, all reasoned in this manner. It is indeed noteworthy that just in our time, in which so much labour and acumen is spent in the analysis of disease into the real causative factor, and into life processes by which the body responds to the injury, we have but lately begun to draw the logical conclusion from that which we have recognized. Modern research has been eminently successful in the incorporation of pathology among biological sciences, and has taught us that a considerable portion of the so-called disease symptoms are life phenomena, which appear with the regularity of a natural law—in other words, that disease is life adapted to altered circumstances. This question now presents itself: Is it possible that the body, in whose phenomena of life during health we are accustomed to observe the most astonishing purposiveness, functionates irrationally during sickness? We must confess that, in spite of all the newly acquired knowledge, we have gone backward; for though the older physicians did not command the grand naturalistic experience and equipment we call ours, a natural instinct has led them on the track now generally conceded to be the right one. Who does not know that fever has been looked upon for ages as a natural remedy purifying the body? And how much labour has it cost to gain adherents to this view, so modified as to be adapted to our modern conceptions! Whoever wants to be convinced of this need only read the great amount of literature on fever which has accumulated during the last half-century.

A similar fate to that of the fever has befallen inflammation. After several older physicians had recognized in-

flammation as a useful process, J. Hunter,[1] a teleologist, appeared as a zealous defender of this view. He especially emphasizes this in a chapter which deals with the usefulness and purpose of adhesive inflammation, and in which he maintains the idea that in a wise way Nature has provided the body with rational means of self-defence.

According to Neumann,[2] S. W. Sachs, in the beginning of the fourteenth century, formulated the views then held on inflammation in these words: "It represents a reaction of the organism for the restoration and assertion of its integrity with increased expenditure of force of all systems."

That the doctrine of the purposiveness of inflammation has been deserted, especially during the last decades, needs no further substantiation. For almost all practitioners recognized to-day as leaders in their profession have been educated as "antiphlogists," who should combat the obnoxious inflammatory processes, and a large majority still cling to this view.

Of late, however, a great change becomes noticeable. The usefulness of the inflammatory processes has been asserted by many authorities. The merit of obtaining recognition for this doctrine, and of placing it on a scientific basis, belongs to Leber,[3] Neumann,[4] Marchand,[5] Buchner,[6] Metschnikoff,[7] Schrakamp,[8] and Ribbert,[9] and one is no false prophet in predicting that it will soon regain supremacy at least in theoretic medicine, though even now the majority of pathologists, as Marchand puts it, "have not yet freed

[1] Hunter, "Versuche über das Blut, die Entzündung und die Schusswunden." Deutsch von Hebenstreit, Leipsic, 1797, vol. ii., part i., chap. xiv.

[2] Neumann, "Über den Entzündungsbegriff" (*Ziegler's Beitrage zur Pathologischen Anatomie und zur Allgemeinen Pathologie*, vol. v., p. 348).

[3] Leber, "Die Entstehung der Entzündung," Leipsic, 1891.

[4] Neumann, *loc. cit.*

[5] Marchand, "Über den Wechsel der Anschauungen in der Pathologie," Inauguration Address in Giessen; Stuttgart, 1882. "Über die natürlichen Schutzmittel des Organismus," Leipsic, 1900.

[6] Buchner, "Eine neue Theorie über Erzielung von Immunität" (*Fortschritte d. Medizin*, 1883, No. 6). "Natürliche Schutzeinrichtungen des Organismus" (*Münch. Med. Woch.*, 1899, Nos. 39 and 40).

[7] Metschnikoff, "Leçons sur la Pathologie comparée de l'Inflammation," Paris, 1892.

[8] Schrakamp, "Über die Entzündung," Leipziger Inaug. Diss., 1892. "Einige Fragen an Physiologen und Pathologen," Schönberg, 1903. "Ein Gutachten über die Entzündung" (*Fortschritte d. Med.*, 1904, No. 30).

[9] Ribbert, "Die Bedeutung der Entzündung," Bonn, 1905.

themselves from the conception that inflammation is a deleterious phenomenon *per se*."

On the other hand, a third life phenomenon of the diseased body—viz., congenital and acquired immunity against infectious diseases—has been accorded almost unlimited recognition as a useful protective measure of the body. It is useless to attempt to discuss these things in the limited space of an introductory chapter, especially since they are as known to every physician as to their discoverer, having aroused a lively interest even beyond medical circles. Though the theories of antibodies, alexins, etc., are still assailable and unsatisfactory, and though it can rightly be said that we are yet far from really understanding these natural healing processes, the facts nevertheless remain solid. And what must be plain to everybody is the really astounding purposiveness of them: the very producers of infection which poison and decompose the body mobilize the fighting agents of the body, by which their toxins are rendered harmless and they themselves are killed.

Thus we recognize in all processes of reaction occurring in the body in infectious diseases the truth of Pflüger's[1] saying: "The injury is the cause of the removal of the injury." In his "teleologic causal law" this genial man said: "The cause of each necessity of a living being is at once the cause of the gratification of this necessity."

Similar views are contained in Ehrlich's "side-chain theory" on the development of antibodies, a theory which has been much recognized and much opposed.

No matter what we may think of the theory, the basic thought that poisonous action and protective action are practically one and the same must be recognized as ingenious and fruitful.

It has generally been acknowledged that the infectious diseases have awakened in us the knowledge that the body itself possesses rational healing agents. To admit this but for one group of diseases is one-sidedness, for an evidently general axiom in Nature cannot concern one kind of diseases only. Interest nowadays is so prominently centred in the infectious diseases that, after a perusal of the newer literature on general pathology, one might come to the con-

[1] Pflüger, "Die teleol. Mechanik d. lebendigen Natur.," Bonn, 1877.

clusion that the other diseases and deformities must step aside, while in reality infectious disease represents only a part—though a very large one—of the diseases.

And we can also see in other diseases how the body most perfectly removes sustained injuries, replaces them, or at least mends them. I need only remind you of what we surgeons expect from Nature. After all, surgery in many directions is a mutilating art. We destroy the beautiful and ingeniously constructed joint, and out of the remaining bone stumps and soft parts expect a new, imperfect yet functionating joint; we ligate the main artery of a limb, assuming that the blood will seek the most tangled side-passages in the affected territory until, in a surprisingly short time, an insignificant branch grows to be a main artery.

These examples could be multiplied indefinitely. I scarcely believe there is any other domain of science like surgery in which Lamarck's law of adaptability embraced by Darwin's doctrine could be better studied. For in most of our operations we must expect this adaptability in a rational sense; otherwise our art would indeed be in a bad plight.

Naturally, like everything else, the rational way in which the body heals its infirmities has its limitations. These are found in the high and complicated organization of the human body. No one expects an amputated limb to grow again, as in salamanders, and on that account we reproach Nature with lack of purposiveness and retrogression in the development of the higher organized beings.

Again, we know that the individual beings of a species vary in regard to the good and the bad side, and that part of humanity which, when taken sick and left alone, succumb to the disease belong to the latter kind of variation. For the very disease is frequently possible only because of a giving away or deficient development of the natural defensive agents, and death from the disease proves that these agents which should be at the disposal of the body are either insufficient or absent. Just in these cases the activity of the experienced physician has to come into play, for frequently it is in his power to strengthen and improve the deficient natural means of defence. Since time immemorial

he has been hailed as the true physician who has learned from Nature her secrets in the healing of disease, who supports her when she is unable to reach the goal by her own efforts, who replaces her when she becomes totally incapacitated, and who controls her when her measures become excessive in their action.

Thus things are theoretically. But theory and practice do not always agree, and nowhere can this be easier proven than in our own profession. Certainly the cough, in the sense I have mentioned above, is a very useful method of defence, yet it can so far overreach the mark and appear in the wrong place as to represent, in reality, the real evil seriously injuring the patient. In the same way, as explained above, we have become convinced that, while inflammation *per se* is a useful process, we are nevertheless frequently compelled to combat all or several of the phenomena to which we apply the collective name "inflammation," and experience with thousands of cases proves that this frequently is very useful.

Exactly the same holds good in regard to fever.

Nothing, therefore, can be more foolish than to attempt to imitate the processes of Nature empirically and without reasoning in the treatment of disease, since we must never forget that frequently the nature of even the best organized being is imperfect, and that Art often is far more effective than Nature. An excellent proof for this is found in the repair of wounds. The physician cures by means of the suture a deep wound, even a yard long, in eight to ten days, without any essential danger to the injured, and re-establishes the efficiency of the severed tissues in the most perfect manner. This Nature can never do, requiring at least months for it, and frequently producing an imperfect restoration of the injured tissues, while the patient during the time of healing is exposed to great dangers and inconveniences.

Nature, therefore, in larger wounds does not know ideal wound-healing, for the simple reason that the several elastic tissues separate, and the main condition for healing by first intention—the apposition of the wound surfaces—is absent.

Certainly our old masters were right when they considered the suppuration of wounds as something useful;

for this reason they spoke of *pus bonum et laudabile*. Art had not yet taught them to keep infection out of their wounds: for their soiled wounds suppuration was the natural and useful reaction; for our wounds it is an undesirable addition.

Weak minds, therefore, while imitating the natural processes in the treatment of diseases, could certainly produce the greatest mischief, as they would in any other occupation. The physician who has nothing else to offer against all diseases save a drug, the surgeon who knows no other curative agent than the knife, is just as dangerous; and I leave it to the reader to decide who is the greater quack, the naturopathic ignoramus, the prescription writer, or the scalpel hero.

Still, all this proves nothing against the general fundamental principle of the purposiveness of the natural healing processes, and against our duty to imitate them at least when, in injuries of the body, they again and again reoccur with the certainty and regularity of a natural law. In this sense, I am sure, the physician is not only justified, but obliged to acknowledge himself a teleologist. In doing so we do not represent a transcendental standpoint, but calculate with a simple fact from experience. Experience has taught us that, on the whole, the phenomena of life are purposive. We know that many of the so-called disease symptoms are bodily phenomena of life, and we also know that some of the symptoms which we have classified as belonging to the injury in reality represent means of defence against it. It is, therefore, but logical that we consider all so-called reactions of the body—and I do not intend to maintain that they are all useful—from this point of view, in order to make practical use of them when we have recognized them as useful agents of defence.

And why should this teleological standpoint be unscientific? Perhaps because we cannot explain it exactly. Where would we land if, in our craft, we demanded explanations for all matters of fact? Even the most exact among our biologists base on equal matters of fact. We all make use of the now popular Darwinistic terms, known to every layman, such as "variation," "heredity," "adaptability." No one doubts that these things are effective in

Nature, but no one has explained them ; they are purely facts of everyday experience.

To many this introduction to the following discussions may appear somewhat far-fetched, but I consider it as very useful, for I shall frequently have to come back to these thoughts in the course of this work, and former experiences have taught me that one must be extremely careful in the expression of teleologic views if one does not want to give offence. Was I not decried in a part of the literature as a mysticist and vitalist, because of these views expressed some years ago in a contribution on the collateral circulation ? Many physicians become nervous[1] when one at all discusses phenomena of life and their purposiveness, even though it be previously explained that under such phenomena of life are meant physical and chemical processes heretofore not at all understood, while the crudest and most improbable mechanical explanation is good enough for them. It is, for instance, so unusually easy to conceive the blood-circulation as a water-conduit, thus conveniently gaining a threadbare scientific cover for all possible things ; but, alas ! this is false. And so many physicians, when they have to discuss the purposiveness of the phenomena of reaction of the body, are afraid to openly admit this. In their discussions they put the word " purposiveness " in quotation marks, or believe themselves obliged to apologize for this admission, in order to save their standing as scientists. Others acknowledge it, but ascribe to it only the value of a " heuristic hypothesis."

I have already said that this is retrogression. For in scientific biology the question whether the organisms and their life phenomena are purposive is not at all discussed, this being accepted as a self-evident fact. Any discussion whatever is limited to the question how this purposiveness of the living beings, as established by experience, should be explained. The Darwinists do this by selection in the sense of the dictum frequently used by them : " Purposive-

[1] Compare Liebermeister, " Handbuch der Pathologie und Therapie des Fiebers," Leipsic, 1875, p. 400: " One must realize among physicians how widespread is the weak fear of all views in which one suspects something of teleology, and how systematically they have been educated in this fear by the preceding generation, who, to be sure, had cause to fight against an unjustified and unscientific teleology."

ness is ability of existence." The vitalists have disputed that this explanation suffices, and ascribe the rational forms and arrangement of the organisms to an as yet mystic force, which, like the old vitalists, they either call " power of life " or, like our neovitalists, choose some other paraphrase.

I believe that at present Darwin's teaching still offers the best explanation in relation to etiology, prophylaxis, and cure of disease : All men provided with good protective and defensive agents avoid or conquer the diseases to which those less favoured in this direction succumb. Each variation in the direction of improvement of these protective agents means a great preference for the individuals, as they have the prospect of living longer and of procreating their species. Each variation in the direction of deterioration, on the other hand, with the great spreading of opportunities for the acquisition of diseases, leads to a quick extermination of those capable of less resistance. The continued selection permits the species to finally inherit the purposive qualities as a safe possession.

GENERAL SECTION

IN ALL IMPORTANT LIFE PHENOMENA HYPERÆMIA IS PRESENT

Every organ that functionates is hyperæmic during its activity. During every form of growth and regeneration local hyperæmia is present, and this in a degree corresponding to the rapidity and energy of the growth. The formation of antlers in the deer and the moulting in birds offer the best examples for this.

Generation and procreation are accompanied by the most pronounced hyperæmia—that of rut and later pregnancy.

No reaction to foreign substances of any kind occurs without hyperæmia, be that substance a crude foreign body or a minute bacterium not demonstrable even with our most powerful magnifying apparatus, a strong chemical poison or a lifeless part of our own body (*e.g.*, blood effused into the tissues). Therefore I believe I may assert : There is no lesion which the body tries to and is capable of removing or rendering harmless that produces anæmia ; it is always accompanied or surrounded by hyperæmia. If we, therefore, accept the reactions of the body as useful efforts of Nature, we must admit that hyperæmia is the most widespread of all auto-curative agents.

The idea that the blood and " juices " heal diseases, and that " bad blood and bad juices " are aiding the development and spread of diseases, is deeply rooted in the minds of the people. But scientific medicine, too, has formed the conception that the quantity of blood of a part of the body is of the utmost importance for its well-being. I intend to show in the following pages that it has proceeded one-sidedly. It speaks of improvement of the circulation,

removal of obnoxious blood-stasis, improvement in the nutrition of the parts by an increased blood-current, and acts accordingly. If we, however, observe how Nature works, we learn that, while it produces in all important processes of the body a local hyperæmia in the parts concerned, the same is produced as frequently by a slowing as by an acceleration of the blood-current.

We will later demonstrate that the latter occurs in the functional hyperæmia accompanying the activity of the organs, while the former prevails when we have to deal with the removal of obnoxious influences and regeneration of new tissue.

If we, therefore, wish to support the healing activity of the body by increasing the useful hyperæmia, we must, if we desire to imitate the processes of Nature, in certain cases increase the blood-current, and diminish it in others. If we act differently, we run the risk of not only doing no good, but harm, by disturbing rational curative processes. We shall therefore have to study the action of the body in each disease, and utilize it as a guide for our intervention. For while in many cases the various forms of hyperæmia have the same effect, in others hyperæmia and hyperæmia are totally different things.

Differences of the utmost importance, physically as well as chemically, exist between the rapidly flowing stream of arterial blood and the sluggish one of more venous blood. Although our knowledge of the blood is as yet very limited, we know that the former is rich in oxygen, poor in carbonic acid and free alkali, presenting a comparatively mobile fluid; the latter, chemically, has just the opposite characteristics, and is a tenacious, sticky fluid. We further know that the rapidly flowing blood retains its liquidity and component parts which it carries along, while the slowly gliding blood sends them out into the tissues, where they can unfold their activity.

We must therefore always bear in mind that the production of various forms of hyperæmia represents a collective conception of many physical and chemical changes.

It must be added that the various forms of hyperæmia cannot be strictly differentiated, as they pass unnoticeably from one into another, particularly, as we shall yet see, since

the body knows how to transform an originally rapidly flowing blood-stream into a slow one, by means of certain stimuli, the nature of which is unknown, especially so by irritation through inflammation. Nevertheless, I prefer to adhere to the conception of hyperæmia rather than attribute the useful and curative properties to certain single components of the blood, which is altogether based on theories not proven.

ARTIFICIAL PRODUCTION OF HYPERÆMIA

Sixteen years ago I began to intentionally subject lesions to hyperæmia in order to cure them, and have widened my experiments, which at first were limited to tuberculosis. I have gained a wide experience in regard to the effect of hyperæmia on physiological and pathological processes, which I present in this work.

When I speak of hyperæmia in the following pages, I mean local hyperæmia only. To avoid confusion, I mention that, following the usage of technical language, I call a part of the body actively hyperæmic when its vascular net is flooded by a larger quantity of blood, while more blood flows in; passively hyperæmic when its vascular net becomes more full on account of a diminished venous outflow (congestion hyperæmia). On the whole, it can be said that active is equal to arterial, passive to venous hyperæmia. But even here we have exceptions. In heart troubles we have passive hyperæmia of the lungs, yet it is arterial (in consideration of the kind of blood: arterial—rich in oxygen and poor in carbonic acid), for the respiration brings oxygen to the blood dammed up in the capillaries of the lungs, and takes away carbonic acid. In such cases a venous hyperæmia can be conceived only when lack of compensation is so pronounced that life is in great danger. This my conception of the arterial hyperæmia of lung stasis has been confirmed by Köster,[1] but disputed in many quarters. I regret that it is impossible for me to accept the objections. In my opinion, lack of reflection only makes possible the concep-

[1] Address before the Niederrheinische Gesellschaft für Natur- und Heilkunde, 1904.

tion of a venous hyperæmia in lung stasis. Even in pronounced disturbances of compensation, the blood in the capillaries of the lungs is more arterial than in the capillaries of any other place in the large blood-cycle.

But these are thoughts which are only to be considered when we discuss an explanation of the effect of one or the other kind of blood. Where we aim at practical ends, we can generally place active for arterial and passive for venous hyperæmia—a liberty we will take advantage of in the course of this work.

PRODUCTION OF ACTIVE HYPERÆMIA

Active hyperæmia can be produced in very different ways. As is well known, physiologists make extensive use of division of vaso-dilating nerves (especially sympathicus division). Strictly speaking, these experiments are not pure, for the division of the nerves produces, besides the hyperæmia, a good many injuries, probably more than we realize; for much can escape our critical investigation. At any rate, this kind of hyperæmia can naturally not be considered for therapeutic purposes.

von Esmarch's artificial anæmia develops very pronounced hyperæmia—the so-called reaction hyperæmia—such as after any temporary cessation or even decided slowing of the blood-current.[1] But it also cannot be used for our purpose, for, first of all, the method is too painful, and then the hyperæmia thus produced lasts only a short time, which leaves it out of the question as an agent for the treatment of such diseases which can be influenced by hyperæmia.

Increased activity of bodily parts (especially of the muscles), friction, massage, and electricity, produce decided active hyperæmia. A good deal of the efficacy of these effective therapeutic agents is probably due to the production of hyperæmia.

We have at our disposal a large number of chemicals—all the rubefacientia—with which to produce hyperæmia.

[1] Bier, "Entstehung des Collateralkreislaufes" (*Virchow's Archiv*, vol. cxlvii., p. 256).

On the first glance at the reddened area, no doubt seems left that we have to deal with an arterial hyperæmia, in accordance with the old medical rule : *Ubi stimulus ibi affluxus ;* still, this does not appear to me as proven. All these remedies produce inflammation, and we know that in this, after a transient acceleration, occurs a slowing of the blood-current. I shall come back to this point later on more fully.

For practical purposes, the most useful agent for the production of local active hyperæmia is warmth. It has been employed in medicine for thousands of years without realization of the fact that the active hyperæmia produced by it is the most prominent, if not the only, curative property. The body protects itself against excessively high degrees of heat by two means : first, by vigorous evaporation of sweat ; and, second, by a voluminous flooding of the heated part with rapidly flowing arterial blood. The latter, therefore, acts like a cooling current. It is principally this accelerated blood-current which we very much desire, for, in my opinion, it is the real curative agent in most of the diseases which are favourably influenced by heat. Nevertheless, it is far from my intention to underestimate the value of sweating as a curative agent. I am of the opinion, however, that it requires no special consideration for the diseases treated in this work.

Warmth can be applied to the diseased parts in many ways—*e.g.*, hot compresses of linseed, bog (or fen), mud, radiating heat, hot sand in the form of specially constructed thermophors, and, finally, hot air.

The highest degrees of heat can be borne only when the last named is employed,[1] for the simple and natural reason

[1] The height of temperature of hot air which can be borne by the skin of the body is variably given in the literature. Originally I made use of air of a maximum of 100° C., and found that this could hardly be tolerated by certain individuals. I made use at that time of large boxes, which enclosed a good deal of air-space, and the thermometer was fastened in a corner. Later smaller boxes were used, but with the thermometer fastened to the cover over the heating source, apparently much higher degrees of temperature were tolerated. The cause is evidently that the thermometer does not correctly register the temperature affecting the skin. The air is variably hot in different parts of the apparatus. Schreiber, whose contribution I shall yet mention, has called attention to this. Not only diverse individuals, but their diverse bodily parts, are variably sensitive to heat. I tolerate for a prolonged period at hand and forearm a maximum of 100° C. (measured with thermometers at both sides and at the same

that air is a very poor conductor of heat, possesses a very limited capacity of heat, and the vigorous evaporation of sweat protects the subjected parts against burns. Thus far the matter is very plain, and, in the manner of laymen, it is astonishing that such high degrees of heat as we are able to apply to the human body without injury are borne. On the other hand, it is less plain how the hot air produces a more decided arterial hyperæmia, which is evidenced by the intensely and equally bright reddened limb, and the greater curative effect than the other named remedies. If the arterial hyperæmia really is the natural protective and reactive process against the obnoxious effect of high degrees of heat, as I accept it, one would conclude that any form of heat, provided it be applied as high as the limit of toleration permits, would produce an equally vigorous hyperæmia.

But it must not be forgotten that the human body, with all its so-called reactionary processes, in the first place is arranged and exercised according to the natural relations by which it is surrounded. Now, our body must continually adapt itself to the widest variations of temperature of the air, while it is but rarely exposed to the variations of heat of other substances with which it comes in contact. If it be packed with heavy, hot substances—bog (or fen), linseed poultice, thermophors—the pressure on the smaller vessels might impede the celerity of the blood-current. I suspect that hot water does not produce a purely active hyperæmia, but that it belongs to the remedies producing slight inflammation, which puts the small vessels and their contents in a condition entirely unknown to us, that, in spite of dilatation of the small vessels, does not produce an acceleration of the blood-current, or, at least, not as much as we would anticipate according to known physical laws. For this reason I cannot approve when ordinary baths of bodily warmth are designated as indifferent. The following simple experiment

height as is the extremity). Rautenberg (*Zeitschr. f. Physik. u. Diät. Therapie*, vol. viii., p. 335) fixes the maximum of temperature that can be tolerated at 100°, 110°, 115° C.

The thin fingers and toes are the most sensitive to heat. For this reason, if the hand or foot is to be treated, and they themselves are not affected, they should be protected against burning by cotton wrapped around them ("Über die Fähigkeit des Körpers, höhere Lufttemperatur zu ertragen," s. Liebermeister, "Handbuch der Pathologie und Therapie des Fiebers," Leipsic, 1875, chap. v.).

shows that, though hot water, as well as hot air, produces intense hyperæmia, the results are different: I place my right forearm in the hottest air I can tolerate (105° C.), and my left forearm in the hottest water (44·75° C.), leave them there an equal time, and place both limbs, after their removal, alongside each other. The red left forearm shows a bluish shade: the right is much brighter, and has a yellowish tinge. The difference is so plain that every observer can recognize it at once. For the rest, the hyperæmia visible on the skin appears rather more intense on the hand taken from the hot water than that from the hot air. The latter, therefore, evidently produces a greater acceleration of the blood-current, and for this reason gives to the limb the higher arterial redness. It is probable that the swelling of the skin by the water presents a chemical change of the tissues, and thus a slight inflammatory circle, for which reason I have frequently substituted hot physiological salt solution, but without causing any change.

But, after all, these are theoretical views, and we are here, as everywhere, left to our practical experience. This seems to prove to me that, among all thermic agents, hot air is by far the most useful, and that it produces the most intense active hyperæmia. Next to it in effect the hot-sand bath might be counted. As my experience with active hyperæmia is almost exclusively limited to that produced by hot air, and as this method of applying heat is universally the most practical and effective, I will essentially confine myself to it.

Hot air of late has been made extensive use of for therapeutic purposes. That the hyperæmia produced by it is the essential thing has until recently been neglected—nay, even denied—and this is sometimes done even now. Thus, at the Fifteenth Congress of Internal Medicine (1895), in the exhaustive discussions on the treatment of chronic rheumatism, not a word was said in regard to it being the hyperæmia which was effective in the recommended treatment by heat, though I had emphasized that long ago. A year later, at the same congress, Tallerman's hot-air apparatus was exhibited, and though Mendelsohn discussed it at great length, my explanation of the effect of hot-air therapy was not mentioned by the lecturer, yet in the previous year

I had again called attention to it.[1] During the discussion Bäumler was the only one who briefly mentioned my explanation at this congress.

For ages the external application of warmth has been counted in medicine among the agents which lead blood from the depth to the surface. Observing the pronounced reddening of the skin after its use, it was concluded that the dilatation of the superficially situated vessels "decongestionated," as it was termed, the deeper parts overfilled with blood. François Franck,[2] in a much-talked-of work on "Revulsion," has attempted to give this opinion a scientific basis; and hydrotherapy, in the widest sense, which is prominently concerned with the application of stimuli by cold and warmth, has unreservedly appropriated his view, and transferred his views to the stimuli of temperature, although Franck talks only of "stimulating inunctions, sinapisms, cupping-glasses, ignipuncture, and vesicantia."

Franck demonstrated that skin stimulation was followed by contraction of the vessels of the viscera and by dilatation of those of the superficial parts, and that by reflex. Irritation of the skin is said to produce a stimulus of the vasoconstrictor nerves of the former, and at the same time of the vaso-dilator of the latter. In this manner, according to Franck, are explained the effects of revulsion. They have a "decongestionating" influence, and draw the blood which stagnates in diseased viscera towards the surface. He thus gave the apparently indisputable scientific explanation, not only for the effect of numerous chemical skin irritants which have been in use since very ancient ages, but also of the many forms of thermic influences, which should be effective in deep parts.

This explanation interests us here very little, as we have but little to do with such extensive distance effects (from the skin into the depth of the viscera). On the first glance it appears very evident, for, as we have long known from

[1] Bier, "Heilwirkung der Hyperämie" (*Münch. Med. Wochenschr.*, 1897, No. 32).

[2] "Über die wichtigsten örtlichen und Allgemeinwirkungen der kutanen Revulsion auf die Zirkulation von François Franck." From the *Gazette Hebdomadaire*, translated into German by T. Fodor (*Blätter f. Klin. Hydr.*, vol. ii., No. 11, 1892).

physiology, an extensive hyperæmia of the external parts is possible only when the viscera give the blood for it, and *vice versa*. But Franck's experiments are by no means convincing. For the purpose of measuring the variations in the volume of blood, he has placed the kidney in a volumetric apparatus. But if the abdominal viscera are exposed, their vessels change from the normal, as I can attest from a wide personal experience, and as is evident from other examinations ;[1] and thus one is led to erroneous views. How much more must this be the case when a whole kidney in connection with its vessels is placed in an apparatus ! For this reason it appears to me very bold to draw such far-reaching conclusions from such crude experiments, which have no bearing on the natural relations.

Let us, nevertheless, accept as correct this effect in relation to skin and viscera, which is also treated in older physiological works. It is hazardous and entirely false to apply these views to parts which are situated close to each other. Thus, Franck's experiments have been cited as proof for the old view that reddening of the skin of a limb frees the deeper parts—*e.g.*, muscles and joints—from an obnoxious hyperæmia. This is a fundamental mistake which has given cause to the wrongest possible views. The agents known as rubefacientia act upon deep parts by producing hyperæmia, and this we shall discuss in detail in a subsequent chapter. I have therefore always taken the view that the hyperæmia produced by heat is not limited to the skin depleting the deeper parts, but, on the contrary, penetrates the entire thickness of a limb which has been exposed, provided the heat be intense enough. My assistant, Professor Klapp,[2] has even proven that it continues from the surface to the viscera : he put the abdomen of a rabbit in a hot-air apparatus, exposed it for some time to intense heat, opened its abdominal cavity immediately on removal of the animal from the apparatus, and regularly found a hyperæmia of the entire abdominal wall, the serosa of the intestines, and of the centrum tendineum of the diaphragm.

Plethysmographic examinations prove that warmth en-

[1] Compare Braam Houckgeest, *Pflüger's Archiv*, vol. vi.

[2] Klapp, " Über die Behandlung von Gelenkergüssen mit heisser Luft " (*Münch. Med. Woch.*, 1900, No. 23).

larges the contents of limbs encased in the apparatus, and that cold diminishes them.[1] Evidently these differences are but due to the changing volume of blood. Unfortunately, these experiments offer no explanation whether the hyperæmia which swells the heated limbs is limited only to the superficial parts, or whether it also spreads into the depth. Thus, Sarah Amitin thinks it possible that, in spite of the increase in volume produced by the warmth, this agent may deplete the deeper vessels.

The most important and decisive proof that heat favourably influences diseased deep parts by hyperæmia, and not by the so-called "decongestion," is the fact, discovered by me, and which I will more fully dwell on in this work, that, on the contrary, a congestion hyperæmia, the removal of which was considered essential, repeatedly shows the same effect as the heat, which is believed to be a derivans or revulsive agent. In this, therefore, utterly false conceptions have been entertained.

The hydrotherapists think that thermic stimuli influence the distribution of blood by reflex. I have already mentioned the experiments by François Franck. They also call attention to the certainly interesting experiments by Brown-Séquard, Schüller, Samuel, Winternitz, and others. They have even asserted that they are able to influence certain internal bodily parts from certain places on the skin. Leichtenstern, in his "Balneotherapy," and Matthes, in his textbook of clinical hydrotherapy, have sharply opposed, partly the correctness of the experiments, partly the justification to make use of them for practical purposes. And, indeed, anyone who has performed similar physiological experiments like those under consideration will assent that Matthes is right when he denies to the large majority of these experiments any value of proof. In this domain prevails a great deal of arbitrariness in the establishment and interpretation of physiological experiments. We will occupy ourselves with these only so far as they here interest us—viz., that the phenomena produced by hot air on such bodily parts as have been exposed to it have been

[1] Sarah Amitin, "Über den Tonus der Blutgefässe bei Einwirkung der Wärme und Kälte" (*Zeitschr. f. Biologie*, vol. xxxv., new edition vol. xvii., p. 13).

placed under the category mentioned above. Whether really in hyperæmia produced by hot air the reflexes play any rôle, no one knows. But we are positive that hyperæmia in its entire extent can be produced without the medium of the nervous system. This is proven by the following experiment : I placed a young white pig[1] under deep ether narcosis, and dissected the femoral artery and vein of one hind-leg clean out of its sheath. I then cut through all other soft parts and ligated all bleeding vessels. The limb now is connected with the rest of the body only by the bone and the two main vessels ; all nerves especially are severed. I then place the limb in a hot-air apparatus, and observe that the hyperæmia appears exactly in the same way as in the other normal limb. The hyperæmia disappears also just as rapidly, provided burns have been avoided. All three degrees of burns can be produced in the dissected leg.

Lewaschew[2] flooded amputated extremities with defibrinated blood, and established that warmth produces dilatation, and cold constriction, of the vessels, and that the rapidity of the outflow was influenced accordingly. Unfortunately, I cannot recognize these experiments as offering proof. I have already explained in an earlier contribution[3] that the flooding of amputated parts of the body with blood freed from fibrin under a constant pressure leads to opposite results, and that these experiments for this reason cannot be made use of.

Pietrowski[4] found in plethysmographic examinations that even parts of the body from which the nerves have been removed have retained irritability of the vessels. The same has been established, also, by other experimenters.

I myself have demonstrated that the so-called reaction hyperæmia, which appears after artificial anæmia, is entirely independent of the central nervous system.[5]

[1] The pig is the best animal for examinations of the distribution of blood. The white skin enables us to recognize any change in the volume or kind of blood with ease.

[2] Lewaschew, "Über das Verhalten der peripherischen vasomotorischen Centren zur Temperatur" (*Pflüger's Archiv*, vol. xxvi., p. 60).

[3] Bier, *Virchow's Archiv*, vol. cxlvii., p. 270.

[4] Pietrowski, "Studien über den peripheren Gefässmechanismus" (*Pflüger's Archiv*, vol. lv., p. 240).

[5] Bier, "Über die während und nach der künstlichen Blutleere auftretenden Gefässveränderungen und ihre physiologische Erklärung" (*Deutsche Med. Wochenschrift*, 1899, No. 31).

Goltz and Ewald[1] show magnificently that the innervation of the vessels is independent of the central nervous system. The vessels of a dog, from whom the largest part of the spinal cord has been removed piecemeal, retain the faculty to constrict or dilate in accordance with the nature of the external stimulus used.

It is therefore positive that hyperæmia by heat can occur solely through local influences on the vessels, without the agency of the central nervous system or the nerve trunks. Whether there exists an immediate stimulation of the wall of the vessel, or whether Goltz is right in accepting vessel ganglia (which so far have not been discovered), remains to be seen.

Finally, it is not even undisputed that the heat produces an active hyperæmia, for Winternitz[2] and his pupils consider it a passive hyperæmia! It seems to me that a glance at the skin of a white creature (man or pig) which, for example, has been exposed to intensely heated air for some time would leave no doubt that there can be anything else but an arterial hyperæmia; for the developed redness is possibly higher and more vivid than that following artificial bloodlessness, and of this we know that it is an arterial hyperæmia with extraordinary acceleration of the blood-current. However, I have tried to support this view by several experiments: I place the leg of a dog which is anæsthetized with ether in a hot-air apparatus for half an hour, and render the extremity very hyperæmic. On opening the previously dissected femoral vein, blood flows from the vein in lively pulsations. This is a repetition of a well-known physiological experiment to demonstrate the acceleration of the arterial blood-current. The bright red

[1] Goltz and Ewald, "Der Hund mit verkürztem Rückenmark" (*Pflüger's Archiv*, vol. lxiii., p. 362).

[2] Compare for this question the contributions by Matthes, "Lehrbuch der klin. Hydrotherapie," second edition (Jena, 1903), and "Über den heutigen Stand der Lehre von der Reaktion im hydriatischen Sinne" (*Zentralblatt für Physik. Therapie und Unfallheilkunde*, 1904). Pick, "Über den Einfluss mechanischer und thermischer Einwirkungen auf Blutstrom und Gefässtonus" (*Zeitschr. f. Heilkunde*, 1903, No. 2). Lommel, "Über den Tonus der grossen Gefässe" (*Deutsches Arch. f. Klin. Med.*, vol. lxxviii.), and "Über die Viscosität des menschl. Blutes bei Schwitzprozeduren" (*ibid.*, vol. lxxx.). Martin, "Beiträge zur Lehre über den Einfluss therm. Anwendungen auf das Blutgefässsystem" (*Zeitschr. f. Diät. u. Phys. Ther.*, vol. vii., No. 8).

of the venous blood, as compared with that seen in the other leg, should be striking. In two experiments I could not establish this. In spite of the ether narcosis, the blood of both veins was bright red. But in the leg which was not rendered hyperæmic the flow of the blood in pulsations was absent.

The following experiments will plainly show that a rapid blood-stream is indeed necessary for the endurance of high degrees of heat, playing the rôle of a cooling stream for the heated limb.

I place my arm in a hot-air apparatus and heat it slowly. When the thermometer shows 114° C.,[1] I can bear the heat very well; at 115° C. a disagreeable burning sensation under the nails appears. The temperature between 114° C. and 115° C. can be borne for some time without difficulty. During this the limb perspires moderately.

Now, the same limb, with a rubber bandage attached to the arm, which produces a moderate induced hyperæmia, is placed in the same apparatus in the same position, and heated in the same manner. At 98° C. a smart burning under the nails appears. Somewhat under this degree the heat can be comfortably borne for some time. Likewise in this case the arm is moist from perspiration.

If I produce in the same extremity a pronounced induced hyperæmia, so that the radial pulse can be plainly felt, and place it under the same conditions in the hot-air apparatus, I have reached at 78° C. the limit of endurance.

Inasmuch as many experiences show that a venously hyperæmic limb shows rather an increased amount of perspiration, it can be but the diminished current rapidity of the blood which is the cause of the greater sensitiveness to the heat; we have slowed the cooling current in this case, which, together with the perspiration, protects against burns.

To make doubly sure, I have also made the counter-test. I render my arm bloodless by constriction for sixteen minutes. On loosening the bandage, the enormous reaction hyperæmia appears, fully known to us surgeons

[1] The temperature which is indicated by the thermometer at the cover of the apparatus need not equal that which affects the extremity. In otherwise equal conditions, however, the thermometer gives satisfactory relative measurements.

as a great acceleration of the blood-stream. The limb is now placed under the same conditions in the same apparatus as before, previously heated throughout to 145° C. The limb bears this heat very well, and perspires freely. I remove the arm from the apparatus, wait until it has entirely paled, and replace it while the thermometer still shows 145° C. The heat can now be borne only for a few seconds ; then it must be withdrawn, on account of the unbearable burning sensation.

In this category come also the following observations : I expose my pelvis in a hot-air apparatus to a degree of heat which can just be comfortably borne. If I now produce retro-congestion by holding the breath and forcible expiratory pressure while nose and mouth are closed, the heat becomes unbearable ; the burning sensation disappears as soon as respiration is resumed.

If I make the same experiment with my arm, I feel the following : In the beginning of the pressure the heat is plainly less felt ; gradually this relief gives way to a sensation of burning. Immediately after the resumption of respiration appears a greatly increased sensation of burning, which again quickly disappears.

All these experiments have been tried by one of my assistants with like success.

That the rapid blood-current is a protective agent against burns is brilliantly demonstrated by the following experiment : I place my arm, on which a slight induced hyperæmia has been produced by means of a rubber bandage, for one hour, in hot air which can be comfortably borne. After paling of the hyperæmic skin, a beautiful net of red stripes remains, which can be recognized without difficulty as corresponding to the network of the small superficial veins of the skin. The larger subcutaneous veins have not marked their course. The red stripes disappear after about twelve hours.

Here we have, therefore, a case of very slight burn exactly in the course of the small veins of the skin, in which, on account of the insignificant stasis, the blood-current has been slowed. No one will demand a better proof of the correctness of my view that the blood-current represents a cooling stream. I have for this reason abstained from

difficult physiological experiments, the results of which may nevertheless be neither certain nor plain. Such experiments have been made by Balli[1] with v. Kriess' flame-tachygramm. He measured with it the rapidity of the blood-current in the human arm, which he had placed in a plethysmograph with hot water of variable temperature. He found that heat enlarged the pulse of the stream, while cold lessened it.

I add that animals which do not at all visibly perspire,[2] but evaporate a little through the skin and produce the regulation of bodily heat by means of the more or less accelerated respiration, such as the dog, tolerate at least the same degrees of heat as does man, of which I have been doubtlessly informed by experiments. I placed limbs of dogs in the hot-air apparatus. They remained dry, but were rendered hyperæmic. In earlier experiments, I have noticed that in dogs of a dark skin the intense reaction hyperæmia after artificial bloodlessness cannot be noticed. If I, however, exposed these dark-coloured limbs to intense hot air, I could not remain in doubt concerning the enormous hyperæmia. In such animals it is no doubt so developed, because the cooling blood-stream must replace the lacking perspiration.

Considerable curative effects have been ascribed to the rich perspiration which follows the application of even local heat. For in many diseases which, in my opinion, are favourably influenced by the reaction hyperæmia of heat, general sweat-cures had been instituted for ages, as, for example, in the stiffened joints of chronic rheumatism, arthritis deformans, and especially in dropsical effusions of the joints. In the latter the idea prevailed that by the dehydration of the entire body the effusion could be made to be absorbed.

I am not so one-sided as to deny that perspiration may

[1] Ettore Balli, "Über den Einfluss Lokaler und Allgem. Erwärmung und Abkühlung der Haut auf das menschliche Flammentachygramm," Inaug. Diss., Berne, 1896.

[2] It is generally believed that dogs do not sweat under normal conditions. The statement of Goltz and Ewald that dogs whose cervical spine has been cut sweat all over the skin with the exception of the part covering the head is the more striking, and is the only one I have seen. At any rate, the extremities of dogs which have been exposed to intensely hot air remain dry to the feel.

prove a great rôle in absorptions in the body; I even do not want to assert that this could not be useful in the affections cited. But the perspiration certainly plays but a secondary part, especially in the affections which are here of interest to us, and in which we make therapeutic use of purely local heat. I have proven this by improving with the hot-air apparatus stiffened fingers singly, in the heating of which there can be no thought of an essential loss of sweat. Therefore the general employment of heat is the most effective agent.

With general hot-sand baths a loss of body-weight up to 3 kilogrammes has been reported; while Mendelsohn [1] experienced a loss of only 750 grammes after subjecting his arm for one and a half hours to a hot-air bath of 120° C.. Krause [2] observed on a female patient on whom he used hourly a hot-air apparatus in seven days 270 to 500 grammes daily. Experience, however, teaches that in the above-named diseases just this local application of heat is the most effective. Now, it is impossible to take the view that local losses of sweat remove absorbable obnoxious substances from its immediate vicinity, in the same sense that the old physicians thought the materia peccans was removed by a derivans.

The following statements by Schreiber [3] appear to me as of importance here: The secretion of sweat begins to be stimulated at low degrees of heat (45-50° C.); at 60-70° C. it is increased, and at higher degrees it frequently becomes less, and occasionally disappears at 80-90° C., so that the skin feels smooth and dry. Schreiber is of opinion that this dryness is not only the consequence of the rich evaporation, but that, on account of the over-stimulation and exhaustion of the nerves of the sweat-glands, really less sweat is excreted. On the other hand, he admits that with increasing heat the hyperæmia becomes more intense, and that this reaches the maximum at the highest degrees of heat. Schreiber thinks that, for the production of rich

[1] Mendelsohn, "Über die therapeutische Verwendung sehr hoher Temperaturen" (*Verh. d. 16. Kongresses für innere Medizin*, 1898).

[2] Krause, "Erfahrungen über therapeutische Verwendung überhitzter Luft" (*Vehr. d. Deutschen Gesellschaft für Chirurgie*, 1899, 18. Kongress II., p. 230).

[3] Schreiber, "Über Heissluftapparate und Heissluftbehandlung" (*Zeitschr. für Diätetische und Physikalische Therapie*, vol. v., brochure 2).

perspiration, lower degrees of temperature are sufficient, and doubts the necessity of obtaining the most intense hyperæmia.

Schreiber's pupils, Rautenberg[1] and Hoffheinz,[2] have confirmed his views by experiment. They come to the following conclusions :

" 1. The secretion of sweat and active hyperæmia have a temperature optimum during the effect of hot air on the skin.

" 2. The favourable point for the secretion of sweat lies at 50-60° C. At higher temperature (80° C. and above) the production of sweat is less, and not more, than, for example, at 40° C. Prolonged effect of hot air diminishes the secretion of sweat, an ' exhaustion ' making its appearance.

" 3. Active hyperæmia occurs at temperatures of 80-120° C. The limit of tolerance for these temperatures differs with individuals."

If I compare with this my own experience, I must remark that to me, too, it seems that the greatest amount of perspiration does not occur at the highest degrees of heat. However, I do not recollect to have observed the dry and shining reddened limbs described by Schreiber as following the effects of high temperatures. Now, coinciding experience points to the fact that in order to obtain good effects high temperatures are necessary, where lower temperatures producing an equal amount of perspiration, but not so intense an hyperæmia, have failed. As, therefore, of both reaction processes—perspiration and increased blood-current—the latter only has become increased, with the higher temperature, it only can be held responsible for the better effect. I therefore do not agree with Schreiber, who says that the intense hyperæmia is not necessary. Certainly, the heat must not rise enough to cause burns, for these probably would stop the active hyperæmia. They lead to inflammatory conditions in the

[1] Rautenberg, " Experimentelle Untersuchungen über aktive Hyperämie und Schweisssekretion " (*Zeitschr. f. Diät. u. Physik. Ther.*, vol. viii., 1905, p. 333).

[2] Hoffheinz, " Über das Verhältnis von Hyperämie und Hyperhidrosis bei lokaler Applikation überhitzter trockener Luft," Inaug. Diss., Königsberg, 1903.

skin, which possibly are followed by a slowing of the blood-current.

The fact that in chronic stiffened joints, those which have not been exposed to heat have improved at the same time as did those which have been thus treated has been argued against the hyperæmia as having the decisive curative properties in affections subjected to hot-air therapy. At first glance, it would seem to speak for a general effect of the locally applied heat influencing the entire body. This conclusion is positively reached by Walsh,[1] Honorary Medical Officer to the Tallerman Free Institute in London. Walsh observed the improvement of an old case of chronic eczema of both hands, which had defied all possible methods of treatment, although only the right hand had been treated with the Tallerman hot-air apparatus. He even believed that a stiff elbow-joint could be improved or cured by local hot-air treatment of a leg, and ascribes this to the general effect of the local hot-air bath, which manifests itself in perspiration, rise of pulse and bodily temperature. I doubt very much if this view is correct ; and though I myself, like many others who make use of this method of treatment, have seen that individual joints which have not been treated have improved, the effect was never as pronounced as in those which have been treated, and very frequently it was absent altogether. Nevertheless, the fact remains, but it can be explained more naturally in a different way. We know that each decided heat effect on external parts of the body draws blood from the viscera to these parts. Therefore, when we have a decided influence of hot air on a part of the body, all other limbs and superficially situated parts participate in the increased flooding of blood. We further know that in multiple lesions, if one of them has been removed, the others may improve. We surgeons know this in tuberculosis, and each of us has seen how an individual has recuperated against all expectation from a grave case of pulmonary consumption after, for instance, the removal of a leg on account of advanced tuberculosis of the knee-joint. Thus, I have also observed that in chronically stiffened joints, such that were not

[1] Walsh, " Hot-Air Treatment of Eczematous, Gouty, Rheumatic, and Other Affections " (*Lancet*, 1900, p. 481).

treated have improved when I subjected the worst among them to congestion hyperæmia. Just such an experience proves best that we do not have here to deal with a general effect of locally applied heat, but, in one as in the other case, with effects of hyperæmia.

The observation of Chrétien, cited by Walsh, who has seen in a case of gout, after the treatment of a gouty joint with hot air, an increased excretion of uric acid from the kidneys, does not speak, as Walsh thinks, for a distance effect on these organs, but all the more for an effect by hyperæmia. I will soon show that active hyperæmia produced by heat has absorptive powers of a high degree. Like all other pathological substances, the hyperæmia will wash away the urinary salts accumulated in the joints, and cause their excretion through the kidneys.

The decisive proof that really the hyperæmia, and not the other phenomena which accompany the application of heat, is the effective agent can again be concluded from the fact that all possible forms of hyperæmia, produced in a different manner, which have no general effects at all, act similarly.

I must remark right here that it seems to me as if the influence of heat on the entire body and on single parts has not been sufficiently separated. It is evidently something entirely different when I place an individual in a hot-air or sand bath up to the neck, or only an arm. In the former case an enormous amount of blood is drawn to the skin, which naturally must be furnished from deeper parts ; in the latter we have a sufficient quantity of blood to render the limb hyperæmic throughout its entire thickness.

APPARATUS FOR THE TREATMENT WITH HOT AIR

To my knowledge, I [1] was the first to design practicable hot-air apparatus for the treatment of local diseases, with the express purpose of producing arterial hyperæmia. I

[1] Bier, *v. Esmarch's Festschrift*, p. 63, Kiel and Leipsic, 1893 ; *Münchener Med. Wochenschrift*, 1899, Nos. 48 and 49 ; *Therapie der Gegenwart*, February, 1902.

have made use of these apparatus since 1891. To be sure, Clado, as I have later learned through the literature on the subject, had produced a hot-air apparatus a short time before, but the latter is so clumsy and uncertain in its effect that it would hardly find any imitators. Clado [1] built an oven with hot bricks, in which he placed tuberculous joints, with the intention of killing the tubercle bacilli by means of heat. The air in the oven registered 130° C., and below the layer of cotton 110° C.

I had no knowledge of Clado's experiments when I constructed my hot-air apparatus, for the publications of that physician had not appeared at that time.

My apparatus [2] are characterized by great simplicity. In principle they are patterned after Quincke's sweat-bed for the entire body.

The heating source for my appliances is Quincke's chimney, which I have modified so that it is fastened to a heavy base, somewhat similar to those used by chemists, and adjustable to any desired height by means of a set-screw. Below the chimney is supplied with a plate for the lamp, which, too, is adjustable.

The apparatus is best heated with gas, by placing beneath the chimney a simple Bunsen-burner, equipped with a stopcock. Regulation of the position of the stopcock permits an increase or diminution of the heat in the apparatus as required.

The gas-flame must be lighted before the chimney is inserted in the box; otherwise it may happen that gas enters the box, exploding on lighting the burner, and singeing the enclosed limb.

In private houses, when no gas is at one's disposal, alcohol will have to be resorted to. After many futile experiments, I had to return to the simplest form of alcohol lamps—a large container with a broad wick. The heat is regulated partially by raising or lowering the wick, partially by altering the position of the lamp. The wick is handled with thumb forceps, as screw adjustments have proved impractical.

I will first describe the simplest form of the hot-air boxes:

[1] Clado, "Report of the French Surgical Congress of the Year 1891."
[2] They are manufactured by Messrs. Eschbaum in Bonn.

A wooden box is saturated with water-glass, to protect it against the danger of fire and cracking by heat, and is covered with sack-cloth, also saturated with water-glass. It contains (depending on the seat of the affection) one or two openings, to enable the extremity to be inserted or exposed. As soon as the extremity is placed in the box, the openings are filled out with fire-proof asbestos cotton. On top the box has one or more draught-holes, which can be made large or small according to requirements, and a thermometer.

To facilitate manipulation of the affected limb and the apparatus, it is better to manufacture the box in halves, on hinges, and to provide the openings with half-cylinders of wood, covered with felt, on which the limb may conveniently rest. This is of the greatest importance, for an

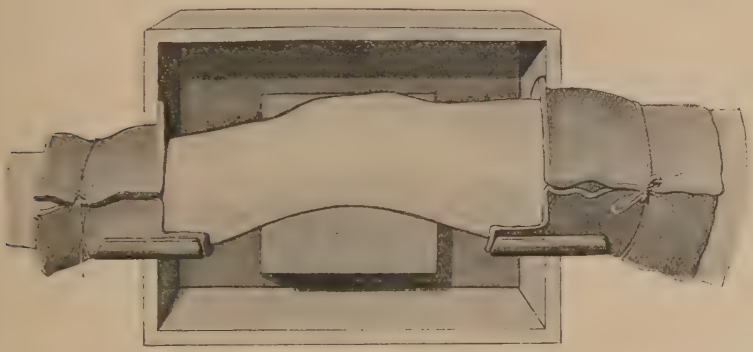

Fig. 1.

inconvenient posture for one hour of a stiffened and painful limb is intolerable and harmful. I believe that in this respect my apparatus excels all others. To economize the cotton, one can place over the openings felt cuffs, fastened to the extremity. Fig. 1 shows such a box for the knee-joint, with the side removed to permit inspection of its interior. Fig. 2 represents a box for the ankle. For rich patients I have every individual box made to measure by a carpenter, to insure exact fitting of the openings to the extremity. The closure must be tight, as otherwise the hot air rapidly streams through the slit between extremity and box, and easily produces burns. For hospitals the openings should have larger diameters, which must be reduced with cotton as needed.

In order to render the boxes applicable for all extremities, the closure of the openings may be accomplished by means of a cuff, like that of Tallerman's apparatus. I have made use of Mosettig cambric, following Krause's example, which has proved useful, though not durable. If one cares to have durable appliances, one had better adhere to those described above.

The cuff is practicable on the apparatus for the shoulder,

Fig. 2.

illustrated in Fig. 3. It is best hung on the wall. The bottom has a hole, through which the affected arm is inserted. The cuff, which is fastened to a felt-lined, pliable metal ring, is drawn over the shoulder. The ring is moulded above the shoulder to fit the body all around, and fastened in the healthy axilla by means of two tape strings, either as a knot or with a buckle. The cuff, however, can be dispensed with even in this apparatus, for it, too, can be so constructed that the opening fits the shoulder-joint.

It is a question whether the part of the limb con-

tained in the box is to be wrapped with cotton or dry-good materials or not. I do not wrap it up, while others do so systematically. It cannot be denied that wrapping lessens the danger of burning the skin and secures a more even distribution of the heat towards all parts of the limb. But, on the other hand, the wrapping material soon becomes saturated with sweat, thus allowing only moist heat to affect the limb, whereby the desired intense arterial hyperæmia is hindered.

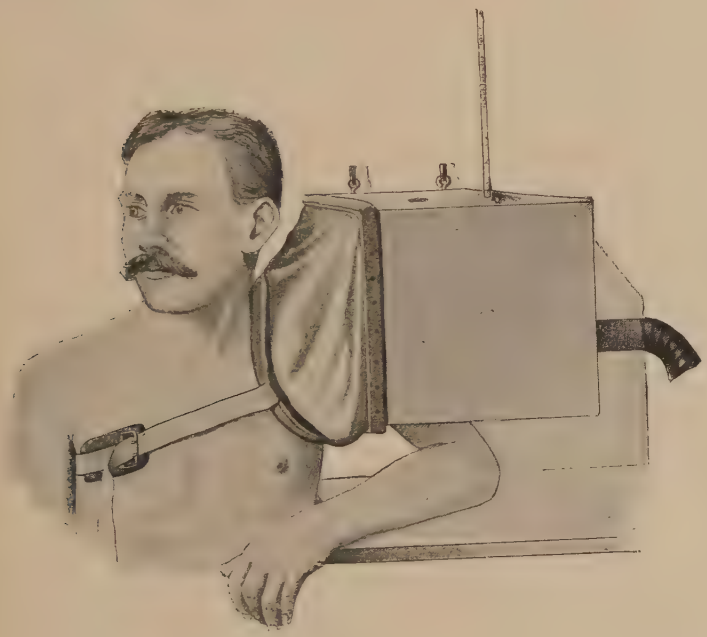

Fig. 3.

Fig. 4 illustrates the apparatus for the hip and pelvis. It is open below, has indentations for the trunk and extremities, and is placed over the patient while in the recumbent posture. The patient for this purpose is best placed on the abdomen, and supported with pillows to insure comfort. I recommend this apparatus also for *one-sided* disease of the hip. Originally I had made use of, for diseases of one hip, apparatus similar to those now in vogue, but now I employ them only exceptionally, as the apparatus illustrated yields more intense and evenly distributed heat.

A detailed description of the apparatus is unnecessary. I refer to the illustration. Naturally, any carpenter can make to measure an apparatus for any bodily part. I have repeatedly ordered appliances for the entire spinal column, which was afflicted with rheumatism.

C. Eschbaum has recently made for me a hot-air apparatus for the pelvis (hip disease, sciatica, lumbago) and back, which is more convenient than the one depicted in Fig. 4. The apparatus has the form of a chair, the back of which is formed by the hot-box, which can be shaped into any desired form to suit the part to be treated. The box has a suitable opening, with felt upholstering, for the reception of the back. On the upper end an adjustable head-rest is attached. The seat being jointed, any position down to

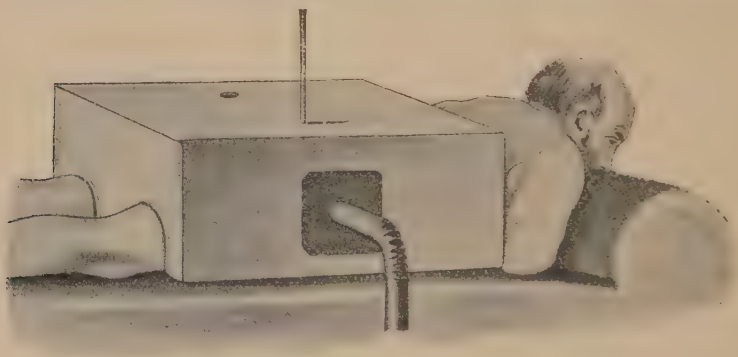

Fig. 4.

the horizontal line can be given the back. A ratchet staff fixes box and seat firmly to each other. A broad upholstered strap prevents the patient from slipping too deeply into the box. The heating appliance is hung eccentrically, and is movable enough to correspond to the changes in the positions of the box. This apparatus has the advantage over my old pelvis and back appliances in that obese and helpless patients can conveniently sit in it, while the apparatus itself is more easily heated.

One and the same box can be utilized for several persons, if it be supplied with variable indentations. We have used such appliances occasionally in the Polyclinic, in order to be able to treat three or four individuals at the same time in one box.

All boxes are supplied with a short iron pipe, which permits the entrance of the heated air of the chimney. This has to enter at a deep level in the box, as otherwise the lower air-space is not sufficiently heated. Naturally, the pipes for all boxes should be of one and the same calibre, so that one chimney can be made use of for all. The heat can be regulated by the depth of insertion of the chimney. Even when the chimney is removed for some distance from the pipe, hot air will pass through the box on account of the draught. To prevent the hot air from directly striking the diseased bodily part and singeing it, a protecting-board, saturated with water-glass, is placed in the interior of the box at the entrance of the pipe, around which the current of air must pass (see Fig. 1).

For some time we have let the air enter the apparatus from below. A broad, arched protecting-board, the ends of which are but a few centimetres away from the side-walls of the box, is fastened over the opening of the heating pipe, which is deeply inserted in the apparatus. Of late, however, I have returned to the old arrangement.

The boxes must be attended by a second person. At first I had attached to the apparatus arrangements for the regulation of heat, but have abandoned them as complicated and unreliable.

My hot-air boxes have had many imitations and modifications, but, I believe, not always improvements. The best known are Krause's [1] apparatus. They consist of a wire net covered with asbestos felt. A belt is suspended from the top, on which the limb is placed. The asbestos cylinder is closed by a cup made from Mosettig cambric, which is bandaged to the introduced extremity. Otherwise the apparatus are essentially the same as mine. As Krause's apparatus are lighter and more pleasing than mine, I used them extensively for some time, but have now entirely abandoned them, because they proved not only less durable, but also less useful than my own. Above all, the air-space in them is too limited, so that the heat strikes too directly that part of the limb which is close to the entrance

[1] Krause, "Die örtliche Anwendung überhitzter Luft" (*Münchener Med. Wochenschrift*, 1898, No. 18), and "Erfahrungen über d. therap. Verwendung überhitzter Luft" (Transactions of the German Society of Surgery, Eighteenth Congress, vol. ii., p. 225, 1899).

opening of the heat-pipe. In this manner one part of the limb is exposed to an abundant degree of heat, while other parts receive too little heat. This can be often noticed by the one-sided redness of the limb. The uneven temperature in the interior of Krause's apparatus, as already mentioned, has been demonstrated by measurements by Schreiber. This shortcoming could, in all probability, be remedied by enlarging the asbestos apparatus. However, the ease with which wood can be made use of to inexpensively manufacture all forms of appliances for any part of the body appears to me an advantage not to be underrated. To avoid unnecessary loss of heat, the walls of the wooden boxes must be thick, as can be seen in the apparatus illustrated in Fig. 2.

The chimney of Krause's apparatus is not practical, because it has three adjustable feet.

Wilson [1] describes "ovens" similar to mine and Krause's apparatus. The fact that he places a salt mixture in the interior of the "oven," which absorbs the excreted sweat, thus keeping the interior dry, is an innovation worth mentioning.

The same arrangement is observed in Reitler's apparatus.[2] Reitler makes use of a dish of pulverized, anhydrous chloride of calcium for the absorption of the evaporated sweat; otherwise his apparatus scarcely differ from those of Krause. Roth [3] has described an apparatus which is said to be free from the deficiencies mentioned above. Roth uses a Krause apparatus, in which he places an asbestos cylinder, thus producing a heat-channel into which the heated air is introduced. The affected limb lies in the inner asbestos cylinder, and is not touched at all by the hot air introduced, which passes along the channel, and heats the walls of the asbestos cylinder, from which the heat is radiated to the interior containing the limb. The air-current in the channel is regulated by a valve, by which means the heat of the air in the cylinder can be controlled. Both spaces have a tube, provided with a valve, which permits the escape of evaporated sweat. This tube is also supplied with a ther-

[1] Wilson, "Hot Air in Joint Diseases" (*Annals of Surgery*, 1899, p. 155).

[2] Reitler, "Die Trocken-Heissluftbehandlung," Baden near Vienna, 1900. Published by A. Dittrich.

[3] Roth, "Eine neue Heissluftapparat-Konstruktion" (*Zeitschr. f. Diät. u. Physik. Therapie*, vol. vi., No. 3, 1902).

mometer, so situated that it registers the temperature of the interior space.

Roth recommends an apparatus known as "polytherm" as suitable for the diverse parts of the extremities, which is similar to the universal box designed by Klapp, and described by me[1] some time ago.

The inventor, above all, ascribes to his apparatus the following advantages: The danger of burning is entirely avoided; the air, evenly circulating around the interior space, produces an even heating of the latter, and the extremity placed within; the heat rises slowly, about 5° C. per minute; the slow rise of temperature and the valve of the interior space are said to make the sensation produced by the excreted sweat fairly tolerable; the temperature registers correspond to actual conditions; the regulation of the heat is absolutely under control.

Of late a whole series of new hot-air apparatus have been produced, which offer nothing new in principle, and, taken all in all, are nothing else but modifications of my models. An American apparatus by Betz, introduced to the trade by Mrs. Kiefer-Kornfeld, has, it seems, found many purchasers, and has been recommended in certain quarters. I have used it for some time, and have thoroughly tested it, but can ascribe to it no advantages. The distribution of temperature in its interior is very uneven. The apparatus is intended for all possible bodily parts. In my opinion, such universal appliances can never fulfil their purpose. My assistant, Professor Klapp, has constructed such apparatus some time ago, but I have abandoned them. Surely special apparatus adapted for individual bodily parts are more rational—at least, for larger institutions—because they permit the limitation of treatment to circumscribed bodily parts and individualization.

Schreiber's repeatedly mentioned observation of the uneven distribution of heat in the popular hot-air apparatus has lead to many attempts to remedy this deficiency. Schreiber[2] himself tries to produce an even temperature by letting the air escape from a lower opening of the chimney

[1] Bier, "Über praktische Anwendung künstlich erzeugter Hyperämie," (*Therapie der Gegenwart*, February, 1902).

[2] Rautenberg, "Beiträge zur Kenntnis der Heissluftbehandlung" (*Zeitschr. f. Diät. u. Physik. Therapie*, vol. vi., Nos. 9 and 10).

through a simple device. The air is thus given a downward direction, and ascends later in an arch. It is possible that an even distribution of heat is obtained in that manner. Schreiber replaces the hot-air boxes with simple arches made of strong cardboard, and covers the free ends with woollen comforters, a slit into which, made wherever desired, permits the hot air to escape. In that manner he secures an appliance similar to one which I have made use of for some time,[1] but since abandoned. I placed hoops over the part to be treated, and covered everything with woollen bed-covers.

Schreiber has led the hot air from the chimney to certain parts of the trunk in a simple and practical manner. He covers the parts with a trail-like coat, and under this roof catches and directs the hot air to any desired place.

Marcuse[2] praises Hilzinger's adjustable hot-air apparatus, which gives air-baths for the whole body as well as individual parts, for producing an even temperature.

Influenced by Schreiber's experiments, I asked C. Eschbaum to so reconstruct my hot-air boxes as to yield an even distribution of heat. Eschbaum, after much labour, led the hot air through twisted channels, so that the thermometer, placed at diverse parts over the bottom, showed approximately the same temperature as when placed at the top. The greatest difference amounted to but few degrees. But we had some peculiar experiences with this apparatus. Several intelligent private patients declared unanimously that it is less effective than the old one. I believe that in the new apparatus the strong draught, and thus also the rapid air-current, is absent—an advantage possessed by the old model. To use a comparison, there exists between the two a similar difference as can be observed in hydrotherapy between a bath taken in quiet water and one in a rapidly flowing river. Eventually Eschbaum has produced in this apparatus a rapid air-current by means of chimneys. But even then they did not prove effective. It seems to me that the production of an apparatus with evenly distributed heat

[1] Bier, "Die Behandlung des chronischen Gelenkrheumatismus, etc." (*Münch. Med. Wochenschrift*, 1898, No. 31).

[2] Marcuse, "Beiträge zur Heissluftherapie" (*Zeitschr. f. Diät. u. Physik. Therapie*, vol. vii., p. 323), and "Heissluftapparate u. Heissluftbehandlung." Urban and Schwarzenberg, Berlin and Vienna, 1905.

is of no special importance. If one, for instance, desires to produce a pronounced effect on an ankle-joint, the toes and front part of the foot should be wrapped in cotton, and bandaged with cloth soaked in water-glass (protection against fire). The water-glass dries, and we obtain a solid half-shoe, which can be slipped over the patient's toes and foot before each treatment. Instead of this, a covering of thick, soft felt can be produced. In the same manner we treat the fingers, which, on account of their thinness, are very susceptible to heat, unless they themselves are diseased. It is evident that high degrees of heat can be applied to the ankle without fear that the toes, situated in the higher, hotter part of the box, will burn. The patient is admonished that, while the temperature is to be as high as possible, the heat must never become disagreeable, and we have to be guided by his statements.

Many hot-air appliances supplied by the trade have the disadvantage that their air-space is too limited, the heat striking the limb too directly and one-sidedly. I observed this from a colleague who was displeased with the moderate results he had achieved with hot-air therapy. When I saw his apparatus and a limb treated therein, which proved to be reddened on only one side, I understood why he had failed.

Klapp has designed a hot-air apparatus for the treatment of fixed scoliosis, for use in the local clinic (Bonn). The apparatus consists of five wooden boxes arranged in a circle, the heating of which is produced by a Bunsen-burner for each compartment. Each of these boxes on its outside has an opening for the back of a scoliotic patient. The openings have different dimensions to suit the sizes of diverse patients. The margins of the openings are upholstered with felt-like cloth, which secures tight closure. Either box can be heated independently of the others. Before each opening is placed a low stool, on which the patient, the upper part of whose body is naked, is seated. He squeezes his naked back into the upholstered opening, and exposes it to the effect of the hot air.

The effect of the box will be discussed in a subsequent chapter on the treatment of stiffness of the joints with hyperæmia.

Tallerman's apparatus, above all other hot-air appliances,

has caused quite a sensation, and it was undoubtedly due to the successes achieved with it that the attention of so many has been directed to this mode of treatment.[1] This explains why at first my apparatus and their imitations have been described in literature, if mentioned at all, as imitations or simplifications of Tallerman's apparatus; this has been changed only after repeated protests on my part. In reality, my hot-air boxes are much older. I have made use of them since 1891, and described them for the first time in the *Festschrift* (jubilee publication) for Fr. v. Esmarch,[2] January 9, 1893—that is, at a time when Tallerman's apparatus were not yet in existence. Later I repeatedly referred to this.[3]

Tallerman's apparatus consists of two containers of copper — one intended for the limbs, the other for the trunk and pelvis. The containers have somewhat the shape of steam-boilers placed on a movable iron stand. The container for the limbs is closed at one end; the other end is provided with a water- and air-tight cloth arrangement, open in its centre, which can be tied to the limb by means of cords. To prevent burning of the limb on the heat-conducting metal walls of the apparatus, the bottom is covered with a rectangular asbestos plate, and the side-walls covered with asbestos felt. Loose asbestos pads and pillows can be inserted wherever needed to protect the limb from contact with the metal plates.

A series of gas-flames placed beneath the closed kettle produces heating of the air. This heating arrangement differs in principle from that supplied by mine and similar apparatus, in that the combustion gases do not enter the apparatus. To maintain a change of air in the apparatus for the purpose of evaporating the large quantities of excreted sweat, several openings have been arranged—one below to permit the ingress of air, and several above for the purpose of egress. The latter can be opened or closed by

[1] The first successes were reported by Sarjeant (*The Lancet*, 1895, p. 112) and Knowsley Sibley (*The Lancet*, 1896, p. 593). In addition, compare the Transactions of the German Congresses for Internal Medicine of 1897 and 1898.

[2] *v. Esmarch's Festschrift*, p. 63, Kiel and Leipsic, 1893.

[3] Bier, "Über verschiedene Methoden, künstliche Hyperämie zu Heilzwecken hervorzurufen (*Münch. Med. Wochenschrift*, 1899, Nos. 48 and 49; and *Therapie der Gegenwart*, February, 1902).

means of stopcocks for the purpose of regulating the temperature in the interior of the apparatus.

Tallerman has laid special stress on the dryness of the air in his apparatus, because moist air, for obvious reasons, acts like steam, so that high temperatures cannot be borne. For this reason he has arranged the valves described above, which maintain a continuous air-current. The same holds good, however, also for mine and similar apparatus, in which a rapid air-current passes, maintaining evaporation and carrying away the evaporated water. To be sure, absolutely dry air cannot be had under any conditions, and not infrequently the bottom of the apparatus can be seen wet from sweat which has run down.

Mine and other apparatus fashioned after them, in which the combustion gases strike the treated bodily parts directly, have in addition the disadvantage that the water formed during combustion also enters the apparatus, making the air moist. Lamberger,[1] in a noteworthy article, has figured out that the quantity of water produced from combustion is considerable. According to him, 200 grammes of alcohol yield more than 211 grammes of water, which enter the apparatus in the form of gas. However, it appears to me doubtful that a very pronounced degree of dryness of the air is really necessary, and whether the reaction which is obtained in the boxes without any special artificial arrangement for the purpose of keeping the air dry does not suffice.

The thing that undoubtedly insures my boxes a place in the treatment with hot air is their great simplicity. Any carpenter and smith can manufacture them from a model. For patients who suffer from a chronic disease, and for whom it becomes necessary to possess such an apparatus, this is not to be underestimated. To this must be added that wood can be easily manipulated, so that the apparatus can be given any desired shape, and arrangements for the convenience of the diseased parts can be instituted with ease—a circumstance of great importance for painful and crippled extremities. For a comfortable position is the first condition for a successful treatment of such limbs. Treatment should never begin until the patient himself

[1] Lamberger, "Über lokale Heissluftbehandlung" (*Wiener Med. Presse*, 1905, Nos. 1 and 2).

is comfortably seated or laid down. If the wooden shells above described, on which the limbs are placed, do not suffice, strings can be drawn through the cover of the box, and the limb still further supported.

It does not, therefore, appear to me probable that my simple boxes are excelled in efficiency by Tallerman's apparatus, or greatly improved by any of the modifications described above.

Electric hot-air apparatus manufactured by several parties seem to be very convenient and practical. They have the disadvantage of being very expensive, difficult to move, and cannot be used everywhere, which narrows their application to limited confines.

Lindeman[1] invented an electric apparatus, which he named "electrotherm." It consists of a massive box, at the base of which is placed an electric heater. The temperature in the interior can be regulated with exactness by means of a rheostat. The limb to be treated lies in an upholstered mould over the heater. A window in the cover of the box enables one to observe the limb during treatment; the interior of the box can be lighted with an electric lamp.

The apparatus has the disadvantage that it can be used only for the extremities, even to the exclusion of hips and shoulders. For the latter an arrangement like that seen in my shoulder-boxes would increase the usefulness of the apparatus, but for the former this may prove more difficult.

Kellog,[2] according to several authors, has arranged his well-known electric-light bath for the local treatment of individual parts in such a manner that it can serve as a hot-air apparatus. This and similar arrangements have found widespread application. I myself have but limited experience with them. But intelligent private patients who had been treated with such apparatus elsewhere have assured me repeatedly that they are less effective than my simple boxes. This is easily understood, for in these apparatus, too, there is no draught; a stagnant air stratum forms around the limb, and the radiating warmth possibly acts less favourably.

[1] Presented at the Seventieth Convention of German Naturalists and Physicians in Düsseldorf, 1898, and *Münch. Med. Wochenschrift*, 1898, No. 46.

[2] According to Přibram, "Chronic Rheumatism," etc., in Nothnagel's "Special Pathology and Therapy," Vienna, 1902.

Nevertheless, I agree with Lamberger, who declares all our apparatus so far produced—even the electric ones—to be imperfect, at the same time speaking of electric heating as the method of the future. He believes the difficulties to have been overcome which were in the way of their rational construction, and promises to report on it at some future time. But, for obvious reasons, they will never displace the old apparatus from the general practice of medicine.

Frey's[1] air douche is a practical apparatus. An electric motor driving a turbine blow-apparatus leads a strong air-current in two pipe-mains. One of them passes through an electric heater, in which the passing air is heated up to + 200° C.; the other through an appliance filled with salt and ice, in which the air can be cooled down to − 10° C. By a simple device the temperature of both air-streams can be regulated and evenly maintained. Frey makes use of the hot-air stream especially in neuralgias, spastic conditions, and chronic articular affections with stiffening—that is to say, in conditions for which hot air has been used for some time. Accordingly, the apparatus in principle offers nothing new, but it has the preference over others that the hot air can be applied through the movable rubber tubing to any bodily part, and one can get along anywhere with this apparatus.

The cold-air douche is an innovation in the apparatus. It may be used alone or alternating with the hot-air stream, somewhat after the Scotch alternating douche employed in hydrotherapy. The apparatus may perhaps render useful service in a variety of diseased conditions.

Frey has added to his hot-air douche massage given at the same time, according to the method employed in Aix-les-Bains with its thermal douches. I can confirm the fact that the union of both agents is practical for many cases.

As a simple hot-air douche, Engineer Conrad Hahn's (of Braunschweig) motor, which I have had in use for the past two years, is more convenient and cheaper. It was lately

[1] Several articles on the same subject: Frey, Address before the Twenty-first Convention of the Balneological Society of Frankfort, March, 1900. *Deutsche Medizinalztg.*, 1900, No. 35.—"Über Beh. mit der Luftdusche" (*Therap. Monatsh.*, June, 1900). "Über die Behandl. von Neuralgien mit der Heissluftdusche" (*Archiv f. Psychiatrie*, vol. xxxiii., No. 2). "Die Massage unter der heissen Luftdusche" (*Deutsche Med. Wochenschrift*, 1900, No. 5). *Archiv f. Physikalisch-diät. Therapie in der Ärztl. Praxis*, 1904, No. 10.

described and illustrated by Bering.[1] The apparatus has the advantage that it yields after a very short period (two to three minutes) sufficient warm air, and that it is small

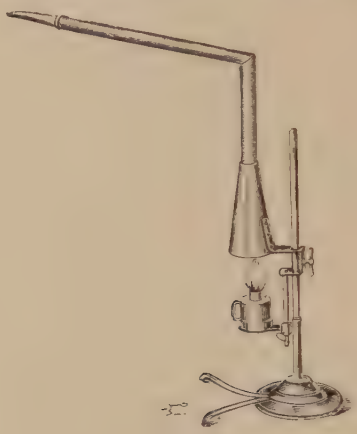

Fig. 5.

and handy. I can recommend the apparatus for hospitals as practical and effective.

Taylor[2] invented a complicated apparatus (named "elec-

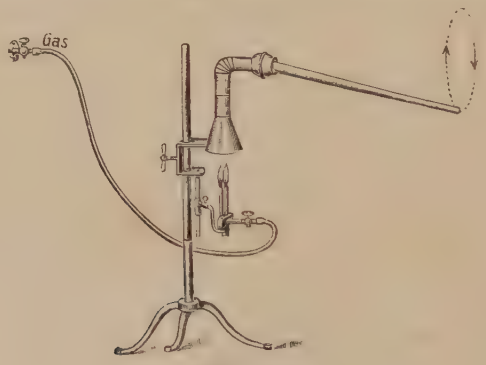

Fig. 6.

trothermogen"), similar to Frey's air douche, for the purpose of healing neuralgia. A fan driven by clockwork drives the air through a glass tube containing a wire spiral.

[1] Bering, "Ein neuer Heissluftmotor" (*Med. Klinik*, 1905, No. 18).

[2] Taylor, "On the Treatment of Neuralgia and Rheumatism by Currents of Hot Air, with Some Account of the Apparatus Employed" (*The Lancet*, November, 1898).

This is heated by an easily controlled electric current, and warms the passing air, which is led to the patient through an opening whose size can be altered.

I have made use for a long time of the chimney of my apparatus as a hot-air douche for trigeminus neuralgia. In order to enable us to get a hold and direct the mouthpiece, I provided a funnel of felt or wood, which naturally permits only a limited mobility. The patient was compelled to move his face in front of the funnel. C. Eschbaum has improved this apparatus in the following manner: The chimney ends in a hollow ball-joint. A metal tube is introduced in the joint, and supplied in front with a mouthpiece of wood, to enable the patient to hold it. The movable tube from which the hot air streams is led against the diseased part to and fro, giving if desired, according to Frey, at the same time massage. The air streaming out can be conveniently and quickly heated to 200° C. by means of a gas or alcohol flame. The simple apparatus serves the same purpose as do the electric hot-air douches. An inconvenience exists when the treatment is applied to the face, as the patient is inhaling combustion gases. (Fig. 5 shows the old, Fig. 6 the new model of the apparatus.)

LOCAL AND GENERAL EFFECTS OF HOT-AIR BATHS ON THE BODY

I DO not intend to discuss here the therapeutic properties of hot-air baths, as I will describe these later in connection with other methods for the production of hyperæmia, which either act alike, or because they produce different forms of hyperæmia, and occasionally have opposite effects. All I am at present concerned in is to discuss the changes which the treated part or body undergoes when subjected to the influence of hot air. A limb[1] placed in the hot-air cylinder described above usually commences to feel moist

[1] I describe here the phenomena on my own forearm. The statements, therefore, concern me only, as different individuals react differently to heat. The temperatures given in the following page are to be regarded as relative ones. We have to deal with an apparatus in which the heat is not evenly distributed in the deeper and higher parts. As the thermometer was fastened to the top not far from the draught opening, the temperatures affecting the limb are in reality somewhat lower than the figures given.

at a temperature of about 50° C. At 60° to 70° C. it commences to perspire more freely. If the limb be exposed for some time to a temperature of 100°, the perspiration is so free that it falls from the limb in drops. If the heat be raised higher still up to the point of endurance (114°), perspiration apparently becomes less. In this I agree with Schreiber.[1]

My arm becomes slightly and unevenly red after a prolonged exposure to air at about 70°; at 80° to 100° C. the colour becomes more pronounced; and if I heat the air to the point of endurance, enormously so and uniformly. We can establish it as a rule that the hyperæmia gradually increases with the degree of temperature and length of application (provided an hour is not exceeded).

If burns are avoided, the entire process is by no means unpleasant; on the contrary, the heat affects the limb agreeably.

After the bright red, perspiring limb is removed from the apparatus, dried, and dressed, the pleasant effect remains for some time, and occasionally this sensation of increased temperature remains in the treated limb for hours. Measurement with the surface thermometer shows objectively a decided after-effect.

It can be regularly demonstrated that that part of the body which has been exposed to hot air has an increased skin-temperature an hour or more after removal from the apparatus. It goes without saying that the measurements should be made at the identical places under equal conditions. I cite the following cases as examples:

Part of Body and Disease.	Temperature before Treatment.	Immediately after Treatment.	Half an Hour Later.	One Hour Later.	One and a Half Hours Later.
Pelvic and lumbar regions (lumbago)	34·8°	36·2°	35·9°	35·2°	34·8°
Second measurement ..	34·9°	36·0°	35·8°	35·4°	34·8°
Knee (hydrops genu)	34·6°	35·8°	35·5°	35·1°	34·9°
Second measurement ..	34·5°	35·6°	35·5°	35·0°	34·4°
Leg (œdema)	34·2°	35·9°	35·0°	34·8°	34·1°
Pelvic and lumbar regions (sciatica scoliotica)	34·9°	36·1°	35·6°	35·4°	34·8°
Second measurement ..	34·6°	—	35·5°	35·4°	34·7°
Third measurement	34·8°	—	35·6°	35·4°	—
Fourth measurement ..	34·8°	36·2°	35·8°	35·6°	—

[1] *Loc. cit.*

In all these cases the diseased parts were exposed for one hour to a temperature as high as could be borne without discomfort.

Apart from these local effects, the patient's body experiences also general ones. These are not desirable for affections which are to be treated with local hyperæmia—and they are the ones with which we are concerned—but they cannot be entirely avoided. As an example, if the forearm only be exposed to heat, the entire body sweats—in one case more, in another less. Personally, I sweat but little throughout the body while my forearm is under treatment ; while others—especially obese or weak persons—sweat considerably. On the whole, in otherwise healthy individuals the general phenomena are relatively insignificant as compared with other forms of high degrees of heat, and this is the unanimous conclusion from experience. Thus, Krause found an increase of bodily temperature of $\frac{1}{2}^\circ$ to a maximum of 1°, and of 5 to 8 pulse-beats ; Reitler an increase in respiration of 3 to 5, and in the pulse of 10 to 20 ; Mendelsohn, as the result of a two-hour exposure of the forearm to air heated to 140° (?), found an average rise of bodily temperature of $0{\cdot}4^\circ$ to $0{\cdot}6^\circ$, the pulse accelerated by 4 to 8 beats. Other observers report similar observations. My own observations in regard to the bodily temperature undertaken in 1891 show similar results at a temperature of 105°. Also, when heating larger parts—*e.g.*, the pelvis —I have frequently observed a decided acceleration of the pulse.

For some individuals the treatment is not entirely harmless, and I will discuss below the obnoxious and disagreeable consequences which the procedure may have.

Not infrequently slight burns of the first and second degree occur without the patient noticing it. This is probably due to the fact—as I shall demonstrate later—that the intense hyperæmia reduces the sensibility to such an extent that the pain due to the heat is not noticed. These burns are usually insignificant and heal rapidly.

According to Krause, burns also occur when the patient's skin comes in contact with the thermometer. In some cases I have experienced disagreeable burns at a time when I made use of boxes of wood rich in pitch. The

latter, being liquefied by the heat, falls down in drops, and burns the skin when striking the extremity. For this reason the hot-air boxes should be made of wood free from pitch, such as alder, poplar, or willow.

Severe burns requiring a long time to heal I have seen but rarely. This happened in individuals who were ambitious to tolerate the highest possible temperatures. For this reason I always caution the patients that the heat must never produce a *painful or disagreeably burning sensation*, and should rise only high enough to be borne without special inconvenience.

Regularly, after prolonged application of hot air, one may observe dirty brown discolorations of the skin in the form of spots and network. Evidently this is decomposed blood colouring matter due to insignificant burns. That the latter lead to disintegration of the red blood-corpuscles is known from the experiments by Lesser[1] and others. Frequently this discoloration follows the course of the small veins of the skin, in which the blood, on account of the slow stream, is most exposed to the influence of the heat. Evidently the red blood-corpuscles of some individuals are weak, for while some do not get these spots at all, others in whom no burns in a clinical sense can be observed show such widespread discolorations that the skin of the treated area looks marbled. This looks very ugly, but we may console the patient with the assurance that these spots will disappear slowly but surely without any treatment.

I have never seen really harmful consequences from extensive decomposition of blood, which theoretically would seem possible.

A disadvantage from which hot-air therapy cannot be freed is the fact that it makes large demands on the general strength of the patient, especially when extensive surfaces are subject to hot air. In anæmic persons treatments are followed by headache, exhaustion, and lassitude. I have not infrequently observed palpitation of the heart. Others have reported even fainting fits. I myself have observed it once in a woman, who was being treated with the hot-air douche for trigeminus neuralgia. Several times the treat-

[1] Von Lesser, "Über die Todesursachen nach Verbrennungen" (*Virchow's Archiv*, vol. lxxix., p. 248).

ment had to be abandoned because of pronounced feebleness following a prolonged procedure. However, these unpleasant after-effects are not frequent. They can be minimized or altogether avoided by applying in such individuals cold compresses to the head during the treatment, avoidance of unusually large surfaces, and by permitting the patients to rest before and after treatment—in short, the usual precautions customary in vapour and sand baths. The length of each treatment should be carefully regulated, beginning with short ones, and increasing the duration gradually. The choice of the time of day is not without importance, which in each individual case must be determined by experiment.

If in spite of these precautionary measures these symptoms still occur, it is best to abandon the hot-air treatment, and to substitute one of the other processes for the production of hyperæmia, which we will discuss later, and which, though acting similarly to hot air, are less effective constitutionally. At any rate, these ill-consequences show that the heat should be applied as locally as possible, in order to avoid such disagreeable general phenomena — another reason against the Universal apparatus which often unnecessarily expose large surfaces of the body to the heat.

Recently Lamberger has shown that some of the complaints of the patients are produced by the increase of the temperature in the room, and especially by the inhalation of carbonic acid, but more especially of the poisonous combustion products of alcohol and illuminating gas. This point is worthy of attention. Hot-air treatment should, therefore, be administered in large rooms with good ventilation. I usually keep the windows open, whenever possible.

Naturally, chill should be avoided. As already mentioned, the bodies of some men sweat considerably, even when only a part of a limb is exposed to hot air. Such individuals must be rubbed dry; if possible, the clothing should be changed, and they should remain during the cold season for at least an hour in a warm room, and rest. If the patients are compelled to go into the open air sooner, they should at least take sufficient exercise. These are well-known rules in hydrotherapy.

Hot air should not be employed too long during the day.

In the great majority of cases we limit it to one hour, other physicians even to half an hour daily. Only exceptionally in stubborn joint effusions we allow the use of this remedy twice daily for one hour when needed. At first I used hot air excessively for many hours daily in tuberculous affections of the extremities. This eventually leads to a hyperæmia which does not disappear during the intervals, and even to œdema. Granulations dry up superficially, but under the dry cover they become so strongly hyperæmic that serious hæmorrhages are apt to occur. In 1891 I treated a large tuberculous ulcer eight to ten hours daily with air at 100° C. The intensely hyperæmic granulations bled twice so profusely that I could only stop it with difficulty by means of compression and elevation.

The method, even of local application, has a powerful effect on the circulation, which was demonstrated to me by the following observations: Several women told me that during menstruation the treatments produced veritable hæmorrhages, while others menstruated too early and too often. A girl eleven years old was frightened by the first appearance of menstruation while her knee was treated in a Universal box. When the treatment was discontinued, it did not reappear. A woman in the climacterium menstruated once more. Two other women suffered from epistaxis after each treatment. For this reason I interrupt the treatment of women during their menstruation.

Finally, I may mention that hot-air baths, as is to be expected from so effective a process, influence appetite and metabolism. While some individuals are not at all influenced by it, others complain of lack of appetite, and with these the treatment should never be instituted close to or after a meal. Others, again, get a good appetite and a strong desire for food. Thus, I treated a gentleman with hot air applied to the pelvis, who became enormously hyperæmic, and perspired freely. He was very much astonished at the pronounced appetite which he experienced after the treatment. On the other hand, thirst appears less than one would expect—a phenomenon with which we are acquainted in the employment of other methods of heat, which produce perspiration.

PRODUCTION OF PASSIVE HYPERÆMIA

It required a good deal of discussion on my part to demonstrate that the application of heat in the manner described is the best means of producing active hyperæmia, and it required detailed proof that the hyperæmia is the essential effective curative agent in the affections of interest to us, because the influence of this remedy was always altogether differently conceived. In the measures we are about to describe, no one will be in doubt that they act solely by hyperæmia, and that it is a passive hyperæmia which we produce. On the other hand, with some of the agents (cupping-glasses and suction apparatus) it is doubtful whether they produce an arterial or venous hyperæmia. At any rate, it is sometimes a matter of view whether we should call a hyperæmia arterial or venous, as they unnoticeably blend one into the other. In the great majority of cases, however, one cannot be in doubt as to the kind of hyperæmia.

Passive hyperæmia, too, like the active form, has been utilized in ancient medicine by laity and physicians. Cupping-glasses and suction apparatus belong to the old equipment of the physician, now almost forgotten and placed aside, though they have been utilized in an entirely different sense than is done by me. Induced hyperæmia of the extremities by a bandage is also a very old procedure, used as a hæmostatic for venesection and against pulmonary hæmorrhages (so-called binding of the limbs).[1]

Passive hyperæmia has already been employed by me for purpose of nutrition and in the cure of bone fractures which would not knit, and if the widely-used expression "Bier's stasis" is to mean that I have introduced the technique of induced hyperæmia, and this name is used even in the treatment of bone fractures, I must decline this. Rather can I claim for myself the introduction of hot-air

[1] Compare Plaskuda, "Untersuchungen über das 'Binden der Glieder,'" etc. (*Deutsches Archiv f. Klin. Med.*, vol. lxxx.).

It is highly interesting that experience led to this logical remedy long before the circulation of blood was known. It was therefore impossible to gain a clear idea as regards the physiologic effect of the congestion bandage.

apparatus, which are often named after Tallerman, because mine existed long before his, and, further, because mine, for general use, are much more useful and practical, and for this reason have been widely adopted, either in their original form or in one of their numerous modifications.

But except for bone fractures and for attempts at nutrition, no one before me has employed induced hyperæmia—nay, warnings have been uttered against blood-stasis in the affections for which I have recommended it, the main duty of the physician having been interpreted to be to remove and combat the inflammatory induced hyperæmia by means of the so-called antiphlogosis. This idea is so deeply rooted in the minds of modern physicians that the majority of them even to-day have an antipathy for the employment of this remedy. But I am convinced that it has a great future, and that the time is not very far distant when physicians will appreciate that the employment of this form of hyperæmia is not only useful in a large number of affections, but also based on logic and science.

And this much I must claim for myself: that I have pointed out to therapy an entirely new avenue, and have originated the teaching of the rational employment of hyperæmia, which heretofore has not even been mentioned, though used unconsciously.

It seems that the first to have hit upon the idea to make use of artificial induced hyperæmia in insufficient callus formation was Ambroise Paré.[1] In the thirtieth chapter of the thirteenth book of his works he at first recites the remedies for the reduction of callus when too large. These consist in diminishing, dividing, and astringent substances.

"If, however, the callus is too small and undeveloped in consequence of the bandage being too tight, or because the limb has been too long at rest without exercise, or the nutrition of the patient was insufficient, the bandage has to be taken off and entirely removed from the fracture. Instead a different kind of bandage should be applied, beginning at the root of the vessels—if on the leg, close to the inguinal region; if on the arm, near the shoulder, and reaching nearly to the seat of the fracture. For by this remedy the blood is expressed and compelled to flow to the injured place."

Naturally, Paré too, like the old physicians who made use of bandaging or "binding" of the limbs, could have

[1] "Œuvres Complètes d'Ambroise Paré," edition by Malgaigne, vol. ii., lxiii., chap. xxx.

had but an imperfect idea of the physiologic effect of the congestion bandage, for he lived before Harvey. This can be plainly seen from the description of the procedure.

I do not know whether Paré's idea to influence nutrition and callus formation by means of artificial induced hyperæmia has found followers. Probably it has been entirely forgotten, which is only natural, to judge from the brevity and lack of clearness of the contribution, until Nicoladoni[1] described in the year 1875 v. Dumreicher's method, which he recommended for threatening pseudo-arthroses without being acquainted with Paré's experiments. v. Dumreicher's idea, to use Nicoladoni's words, was as follows :

" Perhaps we shall succeed in reaching our goal if we are able to send a larger quantity of nutritive material to the threatened place. If we can render the vessels fuller, and if the tissues are in a condition fit to take up the material of which we now have an abundance, an artificially produced and permanently maintained hyperæmia *per se* will exercise a powerful stimulus on the tissues and tissue elements which participate in formation of callus in accordance with the relation of added nutrition to function so well known to each of us. A method which has this as its aim fulfils also another indication—viz., that the once-stimulated production receives continuously material to carry out the construction of callus until complete."

In principle Nicoladoni produced hyperæmia exactly as we produce it to-day—namely, with rubber tubing loosely applied over the seat of fracture, after the manner of the venesection bandage, while that part of the limb situated below the fracture was bandaged with a flannel bandage. He considered, however, v. Dumreicher's original method more effective, which is carried out in the following manner : The limb below the fracture is firmly wrapped in a flannel bandage, with the view of damming the arterial blood-stream, and of directing it away from the bandaged part towards the place of the fracture. Here induced hyperæmia is produced by wedge-shaped compresses placed above and below (Nicoladoni speaks only of fracture of the tibia), with their broad ends turned toward the bone fracture. A bridge in the form of a wooden splint presses the wedges tight against the bone, while a firmly drawn roller bandage keeps the whole in place. The wedges produce an intense hyperæmia in the place of the fracture free from the

[1] Nicoladoni, " v. Dumreicher's Methode zur Behandlung drohender Pseudarthrosen " (*Wiener Med. Wochenschrift*, 1875, Nos. 5, 6, and 7).

pressure, involving, as Nicoladoni has demonstrated, the entire bone down to the marrow.

Except in threatened pseudo-arthroses, this process has also been successfully employed in order to fill bone cavities more quickly.

Nicoladoni, in different places, points to the similarity of the phenomena produced by this method with acute inflammation, not limited to the development of a simple œdema, but similar also in the hardness of the swollen tissues produced by inflammation.

Although Nicoladoni has thus described in detail the effect of congestion hyperæmia on the development of callus and bone regeneration in bone cavities, apparently the usefulness of this procedure has not been recognized, but practically neglected. Bruns,[1] in his book on bone fractures, cites in the year 1886 only five cases in which v. Dumreicher's method had been employed.

But in the same year an elaborate contribution by Thomas[2] appeared, on the effect of congestion hyperæmia on bone fractures with retarded callus formation. He narrates fourteen cases in which he employed this method.

In the first few cases he simply applied a tourniquet above the seat of fracture, and let it remain on for only half an hour daily. Later, however, he used prolonged hyperæmia, and attempted to confine it especially to the place of fracture by applying a rubber bandage above and below so firmly that congestion hyperæmia developed in its region. He depicts the method by an illustration. In order to increase the hyperæmia, Thomas let the limb hang down.

Of the fourteen cases, Thomas treated but four with congestion hyperæmia exclusively. In the other ten cases he used in addition an older method of percussion — viz., he percussed the fractured ends at intervals of a few days to months with a hammer covered with rubber, while protecting the skin against injury with a layer of felt. He intended to excite an inflammatory irritation by this percussion, and from the history of the cases it can be seen that he was successful in this. He produced by it swelling, and

[1] Bruns, "Die Lehre von d. Knochenbrüchen" (*Deutsche Chirurgie*, brochure 27, 1886, p. 597).

[2] Thomas, "Contributions to Surgery and Medicine: Part vi., "The Principles of the Treatment of Fractures and Dislocations," London, 1886.

frequently bloody discoloration in the region of the fracture; that he proceeded energetically can be concluded, because he frequently undertook this operation under ether anæsthesia. The excellent results which Thomas achieved in several grave and hopeless cases makes it apparent that the combination of these two remedies is very useful.

Thomas successfully utilized this procedure, which he terms "damming," in two cases of recent fracture of the patella and in one case in which the quadriceps tendon was torn.

Thomas does not mention v. Dumreicher or Nicoladoni, and wrongly thinks he is the inventor of the method, as he expresses himself in several places.

In the following year Helferich [1] recommended anew the congestion hyperæmia to increase deficient callus formation, and in general to stimulate bone regeneration and bone growth. He produces hyperæmia in the manner described by Nicoladoni as less effective, by loosely placing above the diseased part of the bone a piece of rubber tubing, but firmly enough to create a vigorous venous hyperæmia below. In order to limit the congestion hyperæmia to the diseased portion of the limb, a bandage is applied up to it. Helferich lets the limb hang down in order to make the hyperæmia intense. Rightly, Helferich points out that this method is simpler than the complicated one of v. Dumreicher, and that the peripheral of the two rubber bandages which Thomas applies is superfluous.

He reports eight cases of retarded callus formation in which he has successfully employed congestion hyperæmia exclusively, and three other cases in which he previously nailed together the fractured ends. We will later on discuss more fully his experiments to stimulate bone growth by the same means.

[1] Helferich, "Über künstliche Vermehrung der Knochenbildung" (Transactions of the German Society for Surgery, 1887, vol. ii., p. 249; and *Archiv f. Klin. Chirurgie*, 1887, vol. xxxvi., p. 873).

PASSIVE HYPERÆMIA OF THE LIMBS BY A CONGESTION BANDAGE

This, in practice, is the most important process, and has early been employed in venesection, for "binding of the limbs," and for the cure of pseudo-arthroses.

The rubber bandage is to be applied above the place which is to be rendered hyperæmic, in several turns covering each other, firmly enough to compress the weaker walls of the veins, but not the stronger ones of the arteries. Depending on the firmness of the application, we can produce any degree of induced hyperæmia, varying from the mildest to the most intense form. The changes which take place in the extremities thus subjected to induced hyperæmia I can best describe by some experiments on myself.

I apply to my left upper arm a congestion bandage so as to produce a mild, passive hyperæmia. The bandage is applied only so tightly as not to produce any inconvenience, and so that in attending to one's customary occupation it is forgotten.

First, the subcutaneous veins of the back of the hand swell, next the large subcutaneous veins on the flexor side of the forearm. The skin of the arm gradually assumes a bluish colour, while the palm of the hand and the extensor side of the elbow assume a rosy colour. The back of the hand and fingers are generally bright red. In the skin of the palm one can observe numerous circumscribed white spots varying in size from a millet to a lentil. These can also be found sparingly on the back of the hand. On careful inspection, one can plainly observe the otherwise invisible delicate network of veins of the cutis.

After three hours the skin of the forearm is equally blue-red. The fingers, the region of the elbow, and the back of the hand, are bright red; the last, however, is blue-red around the larger vein trunks. The white spots on the skin of the palm are faded, and can scarcely be seen. The large subcutaneous veins are less prominent; the net of superficial cutaneous veins begins to fade. Prolonged, strong pressure with the finger on the back of the hand demonstrates an incipient œdema. The pulse is full and

forcible, rather stronger than in the other arm. The treated limb is more susceptible to cold than the other one. Pressure with the finger blanches the skin everywhere, but it immediately refills with venous blood. Friction produces even in the bluish discoloured places the most vigorous arterial bright red, which remains for quite a while.

After the bandage has remained *in situ* ten hours, the increasing œdema becomes striking. The largest circumference of the left forearm is 2 centimetres more than previous to the institution of the induced hyperæmia. The impression from the finger remains. After twenty hours, arm and back of hand are equally swollen by œdema, the largest circumference now being increased by $2\frac{3}{4}$ centimetres. The skin of the fingers, of the palm, the back of the elbow, and wrist-joints, is still bright red, the rest of the skin bluish-red. The subcutaneous veins are but faintly visible, no more so than on the untreated arm. They are not only covered by the œdema, but they can no longer be felt as tightly stretched cords as at first. Forcible friction on a bluish-red place produces even now a decided bright arterial redness.

That there exists no crude obstacle for the return flow of the venous blood is evident from the fact that when I stretch my self (the well-known experiment for the flow of venous blood toward the thorax) the arm immediately almost blanches.

Immediately after undressing both limbs feel equally warm. After remaining undressed for some time, the arm which has been treated feels somewhat colder. After a prolonged exposure to cold ($+2^\circ$ C. with wind) on the uncovered back of the hand of the treated extremity, vermilion spots appear, which disappear on pressure with the finger, but reappear immediately.

This degree of congestion on a healthy arm produces little or no reduction of the temperature of the skin. An experiment on my arm shows :

Previous to treatment	31·8°
Ten minutes later	31·0°
After an hour	31·9°
After about one and a half hours	32·5°
Immediately after removal of the bandage after one and three-quarter hours ..	32·2°

If the rubber bandage is applied just as firmly on an inflamed extremity, the consequent conditions are generally more pronounced, and this in proportion to the intensity of the inflammation. As is well known, all inflamed limbs are warmer at the affected place. Even in chronic tuberculous inflammations this increase of temperature is considerable. The differences, as compared with the same place of the healthy limb, range between 1° to 3° C., and more, in favour of the affected part.

I notice that the comparative measurements must be undertaken in exactly symmetrical places and under equal conditions. One must not, for instance, place the two uncovered extremities alongside each other, and then proceed to measure first the one and then the other, because the latter in the meantime has cooled off. The former also is important, because different places of the same part of the extremity have normally a variable temperature.

Thus, for reasons easily understood, the skin of the palm is always warmer than that of the back of the hand.

In contrast to this moderate induced hyperæmia, which is the one mostly employed in practice, I now proceed to describe the phenomena produced by a firmly applied bandage. Auspitz[1] has excellently and minutely described them in 1874. The observations made by me on myself and on one of my assistants are almost totally in accord with those made by Auspitz. I differ from him only in the interpretation of the phenomena in many points.

When I apply to my left upper arm a rubber bandage so firmly that it produces the strongest possible venous hyperæmia, below the bandage I feel the pulsating, beating artery. Even after two minutes, the subcutaneous veins swell very much, and the skin becomes livid, its shade being bluish to greyish red. In the palm one can observe several bright red spots, while on the posterior side of the elbow, on the back of the hand, and on the radial side of the forearm, below the congestion bandage appear vermilion and yellow spots. The vermilion spots increase and enlarge, and become confluent, so that after seven minutes the greater part of the skin is vermilion. The bluish redness remains

[1] Auspitz, "Über venöse Stauung in der Haut" (*Vierteljahrsschr. f. Dermatologie u. Syphilis*, 1874, i., p. 275).

longest in the middle of the flexor side of the forearm and on the back of the hand. Pressure on the vermilion skin produces a white spot, which immediately after the cessation of pressure reassumes its colour. On the flexor side below the congestion bandage develop numerous carmine red points (small hæmorrhages). In the arm appear sensations of heaviness, fatigue, prickling, and cold and warm alternately. The fingers feel cold. After twenty minutes the skin of almost the entire constricted arm becomes vermilion ; the blue-coloured places have still more receded. By friction on the back of the hand a vivid, bright hyperæmia can be produced. The skin does not assume a rosy hue, but has a decided shade, partially yellowish, partially copper colour. The point-like hæmorrhages increase. The tightly stretched subcutaneous veins are less visible and perceptible to touch. Yellowish-white spots develop in the palm and on the tips of the fingers. The limb becomes numb and cold to the feel, but subjectively one has a sensation of warmth in the arm.

In the course of the induced hyperæmia the skin of the palm becomes ashen grey, interspersed by vermilion and white spots. The vermilion spots become white on pressure with the finger, and then one can see at that place numerous point-like hæmorrhages. After cessation of the pressure, the vermilion colour reappears rapidly.

After forty minutes the intense congestion hyperæmia produces an intolerable sensation of pain, so that the bandage must be loosened. I at once experience a decided sensation of cold in the arm and a feeling as if it were faradized. These sensations are most pronounced in the tips of the fingers. The skin in the part of the limb which has been constricted commences to assume a rose colour in about the same degree as is observed in artificial bloodlessness which has been employed for three to four minutes, only the fingers remain deathly pale for a little while, similar to that observed in some individuals after a cold bath. One and a half minutes later they become bright red, and in the entire limb appears a sensation of warmth. Even three-quarters of an hour after the removal of the bandage I still have a sensation of stiffness of the muscles and fatigue in the arm. In the skin one can see numerous

carmine-red point-like hæmorrhages. After twenty-four hours these blood-points have faded, and appear bright to yellowish red. The skin of the constricted extremity shows a decided yellowish-brown colour, particularly so in the bend of the elbow and below. It is most pronounced there where the point-like hæmorrhages are most numerous. This discoloration is in sharp contrast with the place where the lowest margin of the congestion bandage was applied. After two days the yellow colour of the arm has faded considerably. The blood-points can only be recognized on careful inspection, as yellowish-brown spots. After four days everything has disappeared; the skin appears normal.

During the experiment the temperature of the skin has fallen rapidly. Previously it was in the palm 32·2° C.; five minutes after the institution of the induced hyperæmia, 30·9° C.; after fifteen minutes, 30·0° C.; after thirty minutes, 29·0° C. The limb swells rapidly; as early as ten minutes after the appearance of the induced hyperæmia the circumference of the arm has increased 2 centimetres. Œdema appears but to a slight degree after a duration of the induced hyperæmia of thirty to forty minutes.

I differ in the interpretation of the phenomena in essential points from Auspitz. First of all, he believes that this intense congestion hyperæmia is limited to the skin, and that the deeper veins are compressed not at all or inconsiderably. This is an error. Not only the intense, but the above-described moderate congestion hyperæmia affects the deepest veins (probably principally by means of the compressed main trunk). Of this one can be convinced by applying lightly a congestion bandage above deep operative wounds. We frequently observe that an intense congestion hyperæmia continues into the very depths of the limbs, when in operation an incorrectly applied artificial bloodlessness gives way, and we thus get the same phenomena which I have just described under intense congestion hyperæmia. This hyperæmia even reaches the very bone, for one can observe an increased flow of venous blood from the medullary cavity of the sawn or chiselled through bone.

I have shown some time ago[1] that in total obstruction

[1] *Virchow's Archiv*, vol. cliii., pp. 311 and 312.

to the return flow of venous blood a part of the stased blood goes back through the bone, the vessels of which, naturally, are not concerned in the pressure of the constricting subject. We therefore succeed in rendering hyperæmic, by means of the bandage, the bone into its very marrow.

Auspitz thinks that the vermilion spots which appear in intense congestion hyperæmia are produced by blood colouring matter which enters the tissues. That the latter plays an important rôle I consider probable. We know, through Stricker and Cohnheim, that hæmorrhages occur *per diapedesin* in intense congestion hyperæmia, and we observe point-like hæmorrhages and—what is still more important—yellowish discolorations of the skin of the entire area subjected to hyperæmia, which can occur only from the colouring matter of the blood.

Whether, however, this is the only reason for the appearance of the vermilion colour remains doubtful to me, for we can observe the same patches appear on the skin from short exposures to cold, which causes a considerable hyperæmia of the blood, but no discoloration of the skin. I also could not convince myself as to Auspitz's statement that pressure with the finger does not cause the vermilion colour to disappear ; in my case pressure always produced a white spot, which quickly again became red. I therefore leave unestablished the cause of the development of these vermilion spots, and only remark that they are, when apparent in large numbers in an extensive area, the perceptible evidence of a very intense and excessive congestion hyperæmia.

As an explanation of the white spots, Auspitz believes them to be due partially to mechanical reasons, partially to Samuel's *itio in partes*. I explain them differently. I have already stated that arteries, and especially capillaries, of external parts of the body resist venous blood which becomes stased in them, and push it forward in the direction of the veins by means of motions of their own.

v. Esmarch's " bloodlessness " as generally understood —bandaging of the elevated limb—is virtually no real bloodlessness, for it permits the blood found in the limb to remain in it. In spite of this, the limb afterward looks deathly pale. If, however, an extremity is constricted

without undue haste with a v. Esmarch bandage while the limb is in the horizontal posture, the normal amount of blood would remain within, because the first turns of the bandage compress the veins in front of the arteries. If one now observe this extremity, it can be seen that the subcutaneous veins, which previously were small, swell considerably, while the rest of the skin becomes pale; this happens even when the limb hangs low, and in surgical anæsthesia, when muscular movements as a propelling power for the blood are excluded. The arteries and veins, therefore, have squeezed out the blood which has become venous and forced it into the veins.

The same white spots which we have noted above in intense congestion hyperæmia can be produced in a greater measure and more numerously by the following experiment: I produce on a man with very white skin a moderate congestion hyperæmia by means of a few turns with a rubber bandage applied to the upper arm until the colour of the skin becomes bluish. Additional turns of the bandage made firmly now shut off the arterial flow, and I let the limb hang down. Originally blue, it now becomes checkered. In the blue parts intensely white spots appear. After fifteen minutes the white spots predominate on the upper arm, the blue spots on the forearm. In spite of the dependent posture, the white spots are present even in the extreme tips of the fingers. In my opinion, it does not suffice here to accept merely a contraction of the smallest arteries through the stimulus of the venous blood; the capillaries, too, must have been participating, because of the pronounced whiteness of the spots. Those interested in further proofs for this I refer to my repeatedly cited contribution on the development of the collateral circulation. We see, however, from the last experiment that arteries and capillaries can further the venous blood by means of motions of their own, and which they do more or less in proportion to the venosity of the blood. I only wish to remark *en passant* that this property represents an extraordinary aid to the circulation of blood in affected parts of the body.

Finally, the observation is of interest, to which Ritter has called my attention, that one can in extremities which are in a moderate congestion hyperæmia, and are at the same

time rendered venously hyperæmic, produce by means of friction the most pronounced arterial hyperæmia, and that this is not entirely lacking even in intense stasis. These observations also point to an independent activity of the vessels, as we have repeatedly seen in this work.

The vivid, bright redness which appears after loosening the bandage in intense congestion hyperæmia is identically the same phenomenon which we observe as a so-called reactive hyperæmia after artificial bloodlessness, and which for a long time was accepted as a pressure paralysis of the vaso-motor nerves. I have already convincingly proved in detail that it means something entirely different, and that it appears after any desired interruption, or even limitation, of the arterial flow. This vivid arterial hyperæmia is the expression of oxygen hunger of the bodily parts, which for some time have been poorly, or not at all, fed with arterial blood, and is a useful process of reaction. That it also occurs after this grave congestion hyperæmia is proof that an impoverishment of oxygen has taken place in the constricted limb.

Intense congestion hyperæmia, therefore, is a very dangerous and obnoxious agent for the limb concerned. Because it leads to a considerable reduction of the temperature, I have called it cold stasis hyperæmia. For this reason I have never employed it in practice. It is, nevertheless, possible that if employed for a short period it could be used for therapeutic purposes. That, if employed for some time, it would be obnoxious and dangerous needs no further explanation. We employ, however, for a short time during the day a form of congestion hyperæmia which, as I will later on describe, stands between it and the above-described moderate stasis hyperæmia.

In the majority of cases I have employed hyperæmia in this manner: A so-called "cured" or elastic (woven) rubber bandage is applied above the seat of affection of a limb in several turns firmly enough to produce the symptoms mentioned in the beginning of this chapter under "moderate congestion hyperæmia." As rubber bandages are sold by weight, Martin's thick bandage, which is usually sold by the trade, is too expensive. I recommend for the arms and thin legs an elastic, thin and inexpensive bandage of a

width of 6 centimetres.[1] Martin's thick bandage is best used for thick thighs, because thin bandages would become folded, and constrict like a cord. The end of the bandage is fastened with a safety-pin. To prevent pressure from the bandage, it should be lined with a muslin bandage. For this same reason the place of bandaging should be changed (Fig. 7). If in continued stasis the bandage has been applied in the morning at *a b*, it is placed in the evening at *c d*, and returned the following morning to *a b*. Even when the congestion hyperæmia is used for a short time daily, one will do well not to always select the same place for purpose of constriction. In order to prevent blood-stasis in bodily parts not in need of it, the part of the limb situated

Fig. 7

peripherally from the lesion is best enveloped with two or three layers of a linen or flannel bandage.

I have employed this form of congestion hyperæmia in the large majority of the cases I have treated, continuously with but short interruptions, or at least in the beginning continuously, and later with prolonged interruptions. But one must anxiously watch that the above-described hot stasis is maintained, that the congested limb never feels cold to the touch, or even shows the vermilion spots described above. Furthermore, this form of stasis must never produce inconvenience, pain, or hyperæsthesia, in the treated limb. The patient who wears the bandage must suffer so little difficulty from it that while following his usual occupation he forgets its presence. All the same, one

[1] Sold by Eschbaum, Bonn.

succeeds in producing a vigorous hyperæmia with œdema, especially in inflamed parts of the body.

Of late I scarcely make use of this form of induced hyperæmia. I prefer to apply the congestion bandage, shown in Fig. 8, in such a manner that the turns of the bandage do not fully cover each other, but surround a larger part of the limb. Only when the disease is high in the shoulder or hip the individual turns must cover each other. Above all, I very seldom wrap the peripheral part of the limb, so that the whole procedure is very simple, consisting only of the application of the rubber bandage

Fig. 8.

(after the manner of bandaging for venesection) above the disease focus. Fig. 8, therefore, represents the normal procedure for the congestion hyperæmia.

The prolonged congestion hyperæmia extending over twenty to twenty-two hours daily, which I am in the habit of applying in acute inflammation and in some chronic joint affections, which will be described later on, I have given up as far as the treatment of tuberculosis is concerned; for it requires constant and anxious supervision to make sure that hot congestion hyperæmia is maintained. Furthermore, as I will discuss later on, it undoubtedly leads to changes

for the worse in this disease, if a chronic œdema appears which is artificially maintained for a prolonged period.

I will here add another observation which I have made not infrequently after a prolonged application: If the remedy is stopped, the previously hyperæmic limbs are strikingly pale, if they have not developed a yellowish hue, due to small extravasations of blood. We see here the occurrence of a reaction following prolonged and frequently venous hyperæmias, similar to the one known to us for a long time as following arterial hyperæmia. As is well known, people whose skin is much and frequently rendered hyperæmic by heat stimulus—such as bakers, stokers, glass-blowers—are very pale when away from their work. I do not want to attempt to explain this, but point only to the fact.

At present I apply for tuberculous joints an intense hyperæmia for one to two hours daily, the course of which is briefly as follows: The bandage is so firmly applied that a vigorous congestion hyperæmia is produced. The subcutaneous veins swell considerably, the skin becomes bluish-red, and at about the end of the hour occasionally a light prickling sensation appears in the limb. Real inconvenience or pain, on the other hand, must never occur. The peripheral part of the extremity during this short period of hyperæmia is not enveloped. The process has the advantage of great simplicity and safety. Even if one commit here a technical error, mischief can never be produced, as even after an intense hyperæmia of one hour's duration lasting injuries do not occur.

This form of congestion hyperæmia is not to be pushed so far that the above-described vermilion spots occur. As a rule, a demonstrable œdema also does not appear during the short duration of the application. Should it occur, as it exceptionally does, it is removed as much as possible before the next treatment by elevating the limb. It is fairly immaterial where the congestion bandage is applied as long as it does not come too near the diseased joint. Thus, for instance, the bandage can be applied to the upper arm in disease of the wrist-joint.

I have so far been unable to render the hip-joint hyperæmic by means of elastic constriction, but the method can

be successfully employed on the shoulder-joint ; thus, with the exception of the hip-joint, every joint of the extremities can be treated with this remedy. I describe the technique of congestion hyperæmia of the shoulder-joint (Fig. 9) : Apply loosely around the neck a cloth folded like a tie. A piece of thick rubber tubing is applied from the axilla around the shoulder, one end of which is led below the tie of the neckcloth, the other end outside and around it,

Fig. 9.

pulled so firmly that a strong venous hyperæmia develops in the arm. The rubber tubing is fastened above the cloth with a pair of forceps, which at the same time prevents the tubing from sliding off. To prevent pressure from the tubing, a strip of soft felt or cotton is placed below it (this is not shown in the picture). In order to render the entire shoulder-joint hyperæmic, two strings are attached to the front and rear of the tubing and knotted in the healthy

axilla, while pulling firmly (see Fig. 9). In women it is practicable to attach a ring to the corset on the healthy side, and to fasten the strings to it. These strings are absolutely essential, because without them the rubber tubing would not grip enough over the joint. As a rule I do not wrap the healthy part of the arm, as is illustrated in the picture. Congestion hyperæmia of the shoulder can be obtained more conveniently and in a simpler way as follows : Take pieces of soft rubber tubing of the thickness of a finger, and prepare rings of diverse widths by cutting one end into a point, inserting and sewing it into the other end. The tubing is sewed around with a covering of soft felt, leaving free a piece about 2 centimetres wide. This free portion permits stretching of the tubing. Select a ring which can be slipped over the shoulder-joint under considerable tension. The ring has a broad belt, which, when fastened during tension around the chest, holds the hyperæmizing ring above the joint. Fig. 10 illustrates this procedure.

Under no circumstances should the treatment of the shoulder-joint by congestion hyperæmia be continued for more than twelve hours daily, and even then one must allow intermissions several times during the day, because the tubing—the place of which can, of course, not be changed —would produce harmful pressure.

Generally, congestion hyperæmia can be much more easily produced on the upper than on the lower extremities. The legs of fat women occasionally offer difficulties, but otherwise rarely. Frequently an insufficient congestion hyperæmia can be made very vigorous by first applying the rubber bandage so firmly that a complete bloodlessness is produced, which should be allowed to remain for four or five minutes. Now the bandage is loosened enough so that a strong reaction hyperæmia develops when the same bandage is used as a congestion hyperæmia agent, which keeps back the blood ; or the affected part can be painted with tincture of iodine until an intense inflammation of the skin is produced. The congestion bandage then produces a vigorous hyperæmia in the inflamed area.

Congestion hyperæmia of the head and testicles requires a special description. Congestion hyperæmia of the head

can be easily produced by an elastic bandage, which can be purchased at little expense in any draper's. For adults we have made use of one 3 centimetres wide, for children 2 centimetres wide. A piece almost long enough to correspond with the circumference of the neck is cut off. The bandage has at one end a hook, at the other a series of eyes placed behind each other so that the bandage can be placed at different lengths. The eye into which the

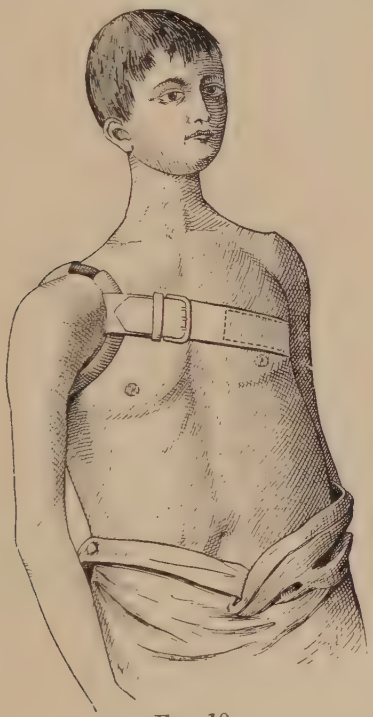

Fig. 10.

hook is to be fastened is recorded. As these bandages lose their elasticity very quickly, they are replaced every four to eight days by new ones. The bandage is closed at the back of the neck, because the skin there is tougher. To prevent pressure from the hook and eye, the skin is first covered with a piece of felt. If the skin is very tender, the bandage is lined with muslin. For reasons easily understood, patients in the erect posture can tolerate greater constriction than in the recumbent posture. Slight lividity

must be produced, and in acute inflammation a pronounced œdema ; but at no time must there occur any serious inconvenience.

Congestion hyperæmia of the head produces less difficulty than one would imagine, even if it be maintained twenty to twenty-two hours. I have tried it on myself before applying it to patients. I have worn the congestion bandage for five consecutive nights around the neck so firmly that the face showed decided congestion hyperæmia and lividity.[1] The first day the bandage caused inconvenience, and I suffered the following day from headache. After this the difficulties ceased. I slept well, performed my customary labours without trouble, and had no headache.

In order to become acquainted with the consequences of intense congestion hyperæmia, as I would never dare employ it on a patient, and in order to guard myself against surprises, I wore the bandage one night, constricting to the point of toleration. It cost me an almost sleepless night, caused buzzing in the ears, beating pulsation within the cranium, and frontal headache. I had to temporarily loosen the bandage. After its removal the next morning, the eyelids were swollen, the conjunctiva reddened, and I suffered from frontal headache up to noon. Other inconveniences I did not notice.

Naturally, congestion hyperæmia of the head will not be used at all, or very guardedly, on people suffering from arteriosclerosis. In the last few years I have used it extensively, in all possible forms of acute inflammation of the head, especially in acute otitis media, grave parulis, acute dacryocystitis, etc., as we will see farther on. It has also rendered me good service in chorea and in anæmic headaches.

To produce congestion hyperæmia of the testicles,[2] the diseased testicle or testicles are pulled down firmly, and a piece of rubber tubing, well lined, is placed around the root of the scrotum. Its ends are secured by clamp forceps.

[1] Compare Bier, "Über d. Einfluss künstlich erzeugter Hyperämie des Gehirns u. künstlich erhöhten Hirndrucks auf Epilepsie, Chorea u. gewisse Formen von Kopfschmerzen" (*Mitteil. aus d. Grenzgebieten*, 1900, vol. vii., Nos. 2 and 3).

[2] Bier, "Behandlung chirurg. Tub.," etc. (*v. Esmarch's Festschrift*, Kiel and Leipsic, 1893, p. 28); and "Beh. der Gelenktuberkulose mit Hyperämie" (*Berliner Klinik*, brochure 89, 1895).

Frequently it is advisable to treat both testicles at the same time, even though only one be diseased, because the rubber tubing secures a better hold. As the place of constriction cannot be changed, the rubber tubing, to prevent pressure, should be worn a maximum of twelve hours daily. Congestion hyperæmia of the testicles is easily carried out. I have used it repeatedly for tuberculosis, fistulæ and indurations, which have remained after gonorrhœal epididymitis. Of late others have made use of it with success in recent gonorrhœal epididymitis. The patient, when up, must also wear a wide, well-wadded suspensory.

Blood-congestion is always accompanied by a lymph-congestion. Occasionally one can observe a form of congestion hyperæmia which I have designated as "white." There exists considerable œdema, while the hyperæmia is insignificant. The limb looks œdematous, shining, and white. I have explained this as a predominating lymph-congestion. I can pass this over, because this phenomenon is very rare, and will but add that, according to my certainly limited observations, it is ineffective.

Objections have been made to congestion hyperæmia : that especially in inflammations it is inconvenient, painful, and dangerous. If this method is to be adopted in practice, it must be freed from these reproaches. First of all, as I have already repeatedly done, I assert that any induced hyperæmia which produces decided inconvenience or pain is fundamentally bad. On the contrary, we shall soon show that the pain-relieving effect of this remedy is one of its prominent features. I therefore repeat : Whoever gives pain with congestion hyperæmia instead of relief does not know how to employ it. Exceptionally, cases occur in which, to judge from conditions, one would expect a favourable effect from the remedy ; in reality, however, pain and trouble are aggravated. But even in such cases skilful individualization will lead to the goal. If, however, one should meet lasting difficulties, another remedy should be chosen.

The fear has been expressed that the rubber bandage would produce decubitus at the place of application, or even lead to gangrene of the entire constricted part of the extremity. The former I have observed, when I first made use of rubber tubing for the production of hyperæmia.

Since using a soft, wide rubber bandage, and carefully seeing that when the skin at the place of application becomes irritated, an intermission is made until the skin is healthy, I have seen it but once—viz., in congestion hyperæmia of the shoulder, which is difficult of execution. If the rules I have laid down for the application of induced hyperæmia be followed even approximately, gangrene of the extremities subject to induced hyperæmia can be entirely excluded. I am in the habit of advising assistants, nurses, and patients, that a congestion hyperæmia bandage remaining for a prolonged while must *never* produce pain or paræsthesia in the limb; otherwise it must be loosened immediately. I also tell my assistants that only the patient himself knows whether he has pain, and that they must never be misled into replying: "You are delicate; you must stand this; the bandage is not too tight."

I can therefore assert that those dangers are imaginary, and present only with the crudest ignorance of technique. If one, however, uses remedies which one does not know and control, they are almost always dangerous.

If a congestion hyperæmia bandage be applied to one place for a long time, and the same place of the limb be chosen for constriction, naturally atrophy of the muscle will occur. For this reason the place of bandaging should be frequently changed. Nevertheless, when the remedy has been employed for years atrophy cannot altogether be avoided; it remains, however, insignificant if the place of constriction is frequently changed, and disappears spontaneously after the cessation of the treatment.

I myself had at first to reproach the congestion hyperæmia with the occasional production of hot suppuration and erysipelas in "open" tuberculosis. I reported several bad cases of this sort. I can now assert that they all were the result of a then wrongly employed technique. I then made use of a too vigorous congestion hyperæmia, which led to chronic œdema. As we know from experience, the latter favours the occurrence of acute inflammation. Meanwhile we have developed the technique of congestion hyperæmia to such a degree that this danger is entirely avoided. On the contrary, I will yet demonstrate that the method of congestion hyperæmia practised by us favourably influences the course of many acute inflammations. Thus, since my detailed

contribution on this danger in 1894,[1] I have observed but once the complication of an acute inflammation to an open tuberculosis which was due to the treatment, and this only lately, when we again were occupied with the introduction of a new technique (suction apparatus for the production of hyperæmia in tuberculosis) and had to learn from failures. I shall relate this case in the course of this work.

Things are similar with the other unfavourable observation made by me, the appearance of stasis ulcers under the influence of hyperæmia. These, too, are due to faulty technique.

I am therefore pleased to be able to affirm that the only danger from congestion hyperæmia, which I at first had to recognize as existing, and which I myself was the first to observe and report, was purely due to an error of technique, which can be easily avoided.

Though I have employed congestion hyperæmia for months and years, I have never seen the occurrence of varix peripherally from the place of constriction. This is the best proof for the view already expressed elsewhere, that varix is not due to congestion hyperæmia alone, but that there must exist in addition an affection of the wall of the vein.

To this may be added the observation described in the first part of this chapter, that the subcutaneous veins, which have at first become tightly stretched by the bandage, after a few hours begin to contract so that they scarcely appear dilated.

Henle[2] rightly asserts that the application of the congestion bandage requires a careful and exact technique, because we depend on our own sensation and that of the patient for the estimation of the amount of constriction. To obviate this he has constructed a piece of hollow tubing, which, after being placed around the extremity to be treated, is inflated with air after the model of Riva-Rocci's apparatus for the measurement of blood-pressure. The required pressure is fixed in each case by experiment and measured with a manometer. All that is

[1] Bier, "Weitere Mitteilungen über d. Beh. chirurg. Tub. mit Stauungshyperämie" (Transactions of the Deutsche Ges. f. Chir., 1894, ii., p. 114).

[2] Henle, "Zur Technik der Anwendung venöser Hyperämie" (*Centralblatt für Chirurgie*, 1904, No. 13); and "Zur Technik der venösen Hyperämie" (Transactions of the Deutsche Ges. f. Chir., 1904, i., p. 227).

needed is to establish the right degree of congestion hyperæmia once, after which it can be easily reproduced with the aid of the mercury manometer.

I have made good use of Henle's apparatus in difficult cases.

v. Leyden and Lazarus[1] recommend for the extremities, instead of the congestion bandage, similar rubber bandages to those we make use of for congesting the head ; these can be adjusted by hooks and eyes. Guth[2] makes use of simple adhesive plaster strips, which he draws firmly.

Kozlowski[3] and Tomaschewski[4] have designed apparatus to regulate the pressure of the bandage. I have no experience with the effect of these auxiliary appliances.

It must be added that Hessing's and similar ambulatory apparatus, as I have had occasion to observe, often produce considerable congestion hyperæmia in the diseased joints for which they are worn.

Theoretically considered, one would easily imagine that prolonged induced hyperæmia embracing larger areas of the body would produce a decomposition of blood which may lead to undesirable consequences ; for in induced hyperæmia numerous red blood-discs which exude into the tissues, and perhaps some in the vessels themselves, perish, while important chemical changes take place in the stased blood.

Landois[5] says in his textbook of physiology that the red blood-discs of carbonic acid blood dissolve the easiest, but remarks in his "Transfusion of Blood"[6] that, while carbonic acid blood dissolves easily, the objection that the blood containing carbonic acid was perhaps already in partial dissolution is to be decidedly rejected, for if carbonic acid blood of animals is arterialized it again becomes less soluble.

E. Grawitz[7] mentions that, in highly concentrated blood

[1] v. Leyden and Lazarus, "Über die Beh. der Gelenkentzündungen mit der Bier'schen Stauungshyperämie" (*v. Leuthold-Gedenkschrift*, vol. i.).

[2] Guth, "Die Behandlung entzündlicher Erkrankungen mit Stauungsbinden u. Saugapparaten in der Praxis" (*Prager Med. Wochenschrift*, vol. xxxi., No. 3, 1906).

[3] Kozlowski, *Centralblatt f. Chirurgie*, 1906, p. 83.

[4] Tomaschewski, *Centralblatt f. Chirurgie*, 1906, p. 756.

[5] Landois, "Lehrbuch der Physiologie," tenth edition, 1899, pp. 26 and 27.

[6] Landois, "Die Transfusion des Blutes," Leipsic, 1875.

[7] E. Grawitz, "Klinische Pathologie des Blutes," p. 211.

in heart troubles, while there is a disturbance of compensation the hæmoglobin is loosely attached to the stroma, and thinks it probable that in such cases a greater decomposition of the red blood-corpuscles takes place in the liver.

Chvostek[1] found the serum of congested blood taken from a constricted finger—which, however, lasted but ten minutes—free from hæmoglobin.

That in congestion hyperæmia, which we make use of for therapeutic purposes, decomposition of blood frequently does take place is proved by the slight yellowish colour of the skin which appears after a prolonged application of the remedy.

This frequently is not lacking even when the congestion hyperæmia has been employed for a short period daily and in a moderate degree, occurring especially in inflamed parts of the body. As we generally maintain more prolonged and more intense congestion hyperæmias than those had in view by the above-mentioned experimenters, it is doubtful whether we may not occasionally produce greater decomposition of blood. If this, however, were so, we should be able to easily demonstrate them, for we know from experience, gained from transfusion of foreign blood and from a series of diseases, characterized by immense decomposition of the blood, that in such cases liver and spleen are not sufficient to take up the decomposed blood, but that albumin, and in pronounced decomposition also hæmoglobin, appear in the urine. Furthermore, these cases have fever, which as a rule starts with a chill.

Among the large number of cases which we have treated with congestion hyperæmia, we have but once observed such a thing. It was a weak small boy, who always showed high fever and albuminuria whenever treated with the congestion bandage applied to the thigh, though his general condition remained undisturbed. Both symptoms appeared soon after the application of the bandage, and quickly disappeared as soon as it was removed. In addition, these phenomena have not done him the least harm. Probably in this case we had to deal with a weakness of the red blood-discs, or perhaps also other components of blood as it occurs

[1] Chvostek, "Über das Wesen der paroxysmalen Hämoglobinurie." Published by Deuticke, 1894.

in that puzzling disease known as paroxysmal hæmoglobinuria, in which the slightest external causes, especially cold, produce pronounced blood decomposition, which may follow a course resembling malaria. Chvostek has demonstrated that in such cases congestion hyperæmia could produce this attack. As is well known, albumin and hæmoglobin have been found transitorily in the urine after cold baths.[1]

Reineboth[2] and Reineboth and Kohlhardt[3] found that in rabbits after chilling (immersion in ice-water for five minutes) hæmoglobin is given off to the serum without it passing into the urine. It is more probable that it was consumed by the liver and spleen. The correctness of these experiments is disputed by E. Grawitz.[4]

The following experiment, which I have made on myself for several consecutive days with the same result, would seem to prove that generally an extensive congestion hyperæmia would not produce so decided a decomposition of blood as to make it demonstrable by fever, hæmoglobin and albumin in the urine. I applied high on both thighs a congestion bandage so firmly that the above-described intense congestion hyperæmia was produced; *i.e.*, the superficial veins became prominent, the limbs bluish-red, swollen, showing vermilion spots. I succeeded in this on myself excellently. After a short time a sensation of pricking, numbness and fatigue in the legs occurs, and finally pain, so that it requires the exertion of a maximum of will-power to stand the extensive congestion hyperæmia more than half an hour. In addition, phenomena plainly show that much blood is taken from the rest of the body: the pulse becomes small—increases from 68 to 88; respiration is deeper; there is a sensation of lack of blood in the head and inability to think. After forty-five minutes the congestion bandages are loosened, and all the phenomena

[1] Johnson, "Temporary Albuminuria, the Result of Cold Bathing" (*British Medical Journal*, 1875). Winternitz. "Die Hydrotherapie," second edition, Vienna and Leipsic, 1890, p. 83.

[2] Reineboth, "Experimentelle Untersuchungen über den Entstehungsmodus der Sugillationen der Pleura infolge von Abkühlung," etc. (*Deutsches Archiv f. Klinische Med.*, vol. lxii., p. 63; and *Centralblatt f. Innere Medizin*, 1900, No. 3).

[3] Reineboth and Kohlhardt, "Blutveränderungen infolge von Abkühlung" (*ibid.*, vol. lxv., p. 192).

[4] Grawitz, *Centralblatt f. Innere Medizin*, 1899, No. 46, and 1900, No. 3.

immediately disappear. On the skin can be seen the above-described carmine-red hæmorrhagic points. I could never demonstrate after these experiments albumin or hæmoglobin in my urine, nor a regular influence on the temperature. My general condition was never disturbed by this enormous hyperæmia (which certainly would never be employed for therapeutic purposes), although I repeated the experiment for six consecutive days.

Nevertheless, there possibly was a considerable destruction of red blood-discs. But a not too extensive decomposition of these does not lead to the appearance of either hæmoglobin or albumin in the urine, and in this my experience with transfusion of foreign blood agrees with Reineboth and Kohlhardt.

HYPERÆMIA BY DRY CUPPING-GLASSES

I HAVE made use of the dry cupping-glass for the production of hyperæmia as long as I have employed the latter in the treatment of disease.[1] I have made extensive use of this appliance, and have had it shaped to fit uneven parts of the body to insure it "sticking"; for larger parts I ordered giant instruments. For a while I have neglected the cupping-glass as a hyperæmizing agent, until my assistant, and most successful collaborator, Klapp,[2] who has lately again made use of it, and developed a method for diverse diseases. Since that time the cupping-glass has been one of our most prominent hyperæmizing agents.

It is well known that the cupping-glass is amongst the oldest therapeutic remedies. But when I lately—though, alas! much too late—looked up its literature, I was not a little astonished to learn how extensively and variably this venerable instrument has been used by all peoples of the world, by the lowest primitive and highest civilized nations;

[1] Compare Bier, "Weitere Mitteilungen über d. Beh. chir. Tub. mit Stauungshyperämie" (Transactions of the Deutsche Ges. f. Chir., 1894, p. 94); and Bier, "Über verschiedene Methoden, künstliche Hyperämie zu Heilzwecken hervorzurufen" (*Münch. Med. Wochenschrift*, 1899, Nos. 48, 49).

[2] Klapp, "Über die Behandlung entzündlicher Erkrankungen mittels Saugapparaten" (*Münch. Med. Wochenschrift*, 1905, No. 16).

its history extends to our day. If I had studied the literature at the right time, we could have saved much labour, for I learned that numerous difficulties—to overcome which we had much trouble—had been solved long ago. I furthermore learned that the idea of sucking out pus with the cupping-glass, which I believed was originated by me, had been in use in olden times, and in certain instances has been practised repeatedly. Even to-day some aural surgeons make use of rarefied air to suck out pus. Lately, Sondermann[1] has recommended it; he follows at the same time my example, utilizing a cupping-glass-like instrument to suck out the pus and produce hyperæmia at the same time. He proceeds in a similar manner for suppurating diseases of the nose and its accessory cavities.[2]

He is followed by Spiess,[3] who makes use of his cupping-glass-like instrument to suck up the secretions, and to produce hyperæmia of the nose, its accessory cavities, and of the throat, which is worked by an air-pump driven by an electric motor.

Dr. Muck[4] of Essen has designed such an apparatus for the nose and its accessory cavities, which seems to me simple and very useful. It consists of a glass suction bottle (Fig. 11*i*). The short shank α serves for the attachment of the rubber ball; the widening β to receive the sucked-up liquid; the neck of the bottle, γ, is pressed air-tight into a nostril. The neck of the bottle has a small hole, which is closed with the index-finger while suction is practised. It serves to permit the ingress of air in case the appearance of pain should make this necessary.

The appliance is used in the following manner: The ball is compressed, the neck of the bottle is deeply inserted in a nostril, while the hole is covered by the index-finger. The patient is ordered to compress the other nostril with a finger,

[1] Sondermann, "Saugtherapie bei Ohrerkrankungen" (*Archiv f. Ohrenheilkunde*, vol. lxiv., No. 1, 1904).

[2] Sondermann, "Eine neue Methode, Diagnose und Therapie der Nasenerkrankungen" (*Münch. Med. Wochenschrift*, 1905, No. 1); and "Zur Saugtherapie bei Nasenerkrankungen" (*Münch. Med. Wochenschrift*, 1906, No. 45).

[3] Spiess, "Die therap. Verwendung des negativen Drucks (Saugwirkung) bei der Beh. d. trockenen, atrophischen Katarrhe d. Nase und d. Rachens" (*Archiv f. Laryng. u. Rhinologie*, vol. xvii., No. 2, 1905).

[4] Muck, "Über eine Vorrichtung zum Ansaugen von Sekreten, u.s.w." (*Münch. Med. Wochenschrift*, 1905, No. 42).

and to place the mouth in a position as if he wanted to pronounce the letter *k*, and to hold the breath. If the ball is now released it expands, and diminishes the air in the nose and its accessory cavities.

As far as I can judge, the apparatus appears to be very practical. It has also this advantage, that it can be boiled after each use. For the aural clinic in Bonn a very practical and much simpler appliance has been manufactured by Carl Eschbaum. It has been described by Leuwer.[1]

Perthes[2] has constructed an ingenious apparatus, which has become quite popular, for the continuous suction of pus in empyema of the pleura, by means of thinned air, and for the expansion of the lung.

In olden times the cupping-glass has been extensively used in a similar manner, to suck out poisoned wounds produced by the bite of poisonous animals and rabid dogs—akin to the method of sucking with the mouth, which has been in vogue throughout the ages. In a future chapter on the influence of hyperæmia on resorption, we shall see that the slowing or cessation of resorption caused by the intense congestion hyperæmia produced by the cupping-glass has, in addition, a beneficial influence.

To be sure, no one, it seems, has grasped the idea of making use of the cupping-glass, which had been utilized for all possible and even improbable things, as well as for hyperæmizing purposes. It, too, has been used as a derivans, which was expected to "draw away" the blood, like heat and other palpable hyperæmizing agents, which we will discuss in the subsequent chapters. And yet I believe that it is the very production of hyperæmia which is the most important and successful factor, though the sucking out of the pus from abscesses and fistulæ plays, in addition, an essential rôle. In reality, very frequently, though unintentionally, the cupping-glass produced a hyperæmia when it was applied for suction, even though the rule was laid down not to place the instrument directly over the inflamed part. This doctrine, however, as we shall yet see, was incorrect, for nowhere does the cupping-glass have a greater healing power

[1] Leuwer, "Ein neuer Nasensauger" (*Deutsche Med. Wochenschrift*, 1906, No. 10).

[2] Perthes, "Erfahrungen bei der Behandlung des Empyems der Lunge" (*Mitteil. aus d. Grenzgeb. d. Med. u. Chir.*, vol. vii., Nos. 4 and 5, 1901).

than when put over the very places where it can increase the already existing hyperæmia.

The primitive nations and the older civilized peoples at first utilized as cupping appliances the horns of animals, then excavated pumpkin and bamboo sticks—the knot of which formed the upper end—and similar objects. The end of the instrument had a fine hole, over which the operator placed his mouth in order to thin the air by suction. After this was accomplished, he skilfully closed the hole with a piece of wax or some other material, which as a rule he had in his mouth, by pressing it with the tongue.

Even in the oldest times thinning of the air was accomplished by heat. The cupping-glass was held over a flame, or an easily combustible substance was ignited in it, and placed on the body by a rapid motion of the hand. Or a burning object was placed over a small plate, which served to protect the skin, and the cupping-glass was adjusted over both. These methods of cupping, even to-day, are the most widespread in popular medicine.

It is much more practicable to thin the air in the cupping-glass by means of a suction syringe, with which it can be connected by a piece of rubber tubing. This method, too, is not at all new, but dates back very far. In Eulenburg's "Realenzyklopädie" the introduction of the suction syringe is ascribed to Weiss, who is alleged to have popularized it in the beginning of the nineteenth century. In reality it is much older. Thus, Benjamin Bell[1] writes in the year 1804 that the evacuation of the cupping-glasses by the mouth was replaced by the suction syringe, but that this method, too, has been superseded by heating the air, because it was difficult to keep the syringe air-tight, and inconvenient for manipulation.

The suction syringe in many cases is surpassed, as far as practicability and convenience is concerned, by thinning the air with a rubber ball, which plan has been introduced by Blatin.[2] The ball is attached to the upper end of the cupping-glass. This is applied while the ball is compressed with the thumb. When released the elasticity of the rubber acts as a sucking force.

[1] Benjamin Bell, "Lehrbegriff d. Wundarzneikunst," German translation, Leipsic, 1804, vol. i.

[2] Eulenburg's "Realenzyklopädie," article "Cupping."

Already, in the ages of antiquity, the above-described primitive appliances were replaced by cupping appliances of metal and glass. Their form (bell- or pear-shape) was practically the same as used to-day. For special purposes peculiarly constructed appliances have been used, which during the intervening centuries have not been changed in principle—*e.g.*, side-reservoir for the reception of sucked-up liquids, as still in vogue to-day, especially in breast-pumps.[1]

To insure sticking of the cupping-glass to uneven bodily parts, the margin is thickly covered with fat. For the same reason the appliance can be made so as to fit diverse parts of the body. Round parts of an extremity—*e.g.*, ulnar and radial margin of the forearm above the wrist—are best treated with instruments whose margin has been cut to fit these forms (see Fig. 11*e*). But even still more uneven parts can be fitted by properly cutting away from the margin of the instrument. We use for the purpose of thinning the air the suction syringe[2] and the rubber ball. The manipulation of these instruments requires no detailed description. But I must say a few words in regard to the maintenance of cleanliness of the entire apparatus. For as we make frequent use of it in cases of suppuration, we must absolutely demand that it can be boiled, and, in fact, should be boiled after each use. Originally we used cupping-glasses with the rubber ball attached to the upper end. The entire apparatus was boiled after each use, which procedure eventually damaged the rubber. For this reason Klapp has provided the cupping-glass with a piece of rubber tubing which is permanently attached, but the rubber ball, which is supplied with a metal tube that fits into the tubing, is removed after each use (Fig. 11*c*). As the ball is no more soiled by pus and blood, the glass only requires boiling. After boiling they are preserved in containers filled with bichloride of mercury solution. The ball is boiled if it exceptionally becomes contaminated ; otherwise it is cleansed mechanically with water by sucking up and expelling the liquid.

To catch the pus, a reservoir similar to that seen in breast-

[1] For the history of the cupping-glass, compare Rube, "Studie über d. Gesch. u. d. Mechanik d. Schröpfapp.," Inaug. Diss., Bonn, 1905 ; and Gurlt, "Gesch. d. Chir.," Berlin, 1898, vol. iii., p. 561.

[2] Carl Eschbaum has constructed a syringe which we recommend as excellent. It is provided with a spiral spring, giving automatic action.

pumps is attached to the side of the glass. We consider the most practical the shoe form manufactured by C. Eschbaum[1] (Fig. 11*d*).

To prevent the cupping-glasses from pressing on the skin the margin can be bent. But instruments with a sharp margin stick better to the skin.

The under pressure of the cupping-glasses provided with a rubber ball is greater than one would imagine. Rube estimated it, with firmly compressed ball, at 200 to 400 millimetres Hg.

The employment of cupping-glasses in diverse diseases will be considered in a special part of this book.

I believe that the cupping-glass produces hyperæmia of the deeper structures having a similar action to heat and the chemical derivantia, which point we will investigate later on, and also that the healing effects which have been ascribed to it as a derivative belong in the greater part to its hyperæmizing effect. To be sure, I cannot produce the positive proof for this, for it is here more difficult to establish than with the other agents, as the circulation of blood and lymph in the living organism can be followed only with extreme difficulty, and the distribution of blood in the corpse, as I shall explain in the chapter on chemical derivantia, proves nothing. Here, too, we may lay stress on the error that has been committed. Thus Unverricht believes he finds the proof of the derivative effect of the cupping-glass, because after its use in pleuritis he found the pleura anæmic.

The cupping-glass undoubtedly produces a congestion hyperæmia, which, with intense thinning of the air, may produce it in the highest degrees, up to complete stoppage of the circulation. This is proved not only by the dark blue colour of the hyperæmia, but also by the experiments, which we will eventually take up, and is to be attributed to the prevention of resorption from poisoned wounds, over which a cupping-glass has been placed. Nevertheless, if placed with moderate thinning of air over healthy skin, it produces evidently an arterial hyperæmia, to judge from the bright red

[1] To prevent the pus from entering the tubing during suction, when a shoe-shaped glass cannot be had, I have caused Eschbaum to manufacture suction-glasses with attachments of glass bent into the form of the letter S.

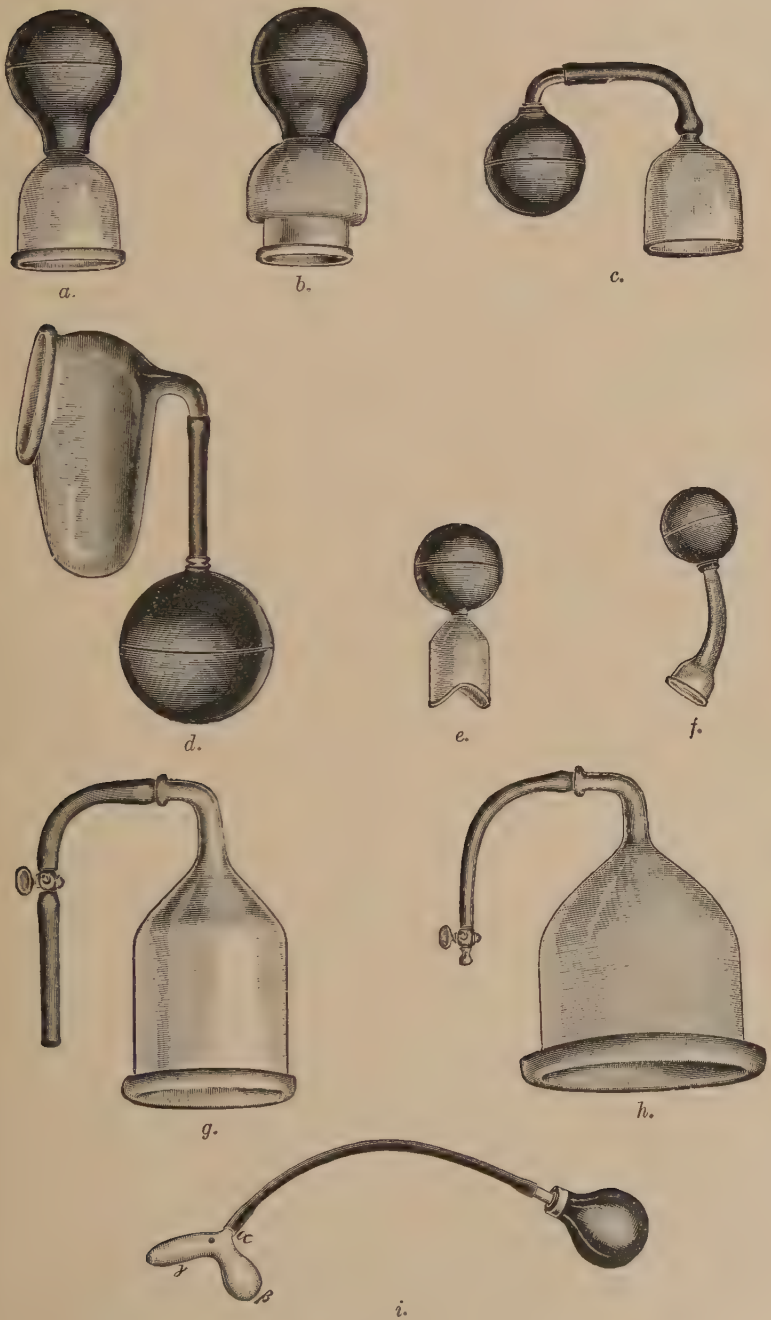

FIG. 11.

colour. It is interesting to note that when the same degree of air-thinning is induced over an inflamed—*e.g.*, tuberculous—part of skin, the hyperæmia appears much darker. The explanation for this will be given later.

For these reasons I have formerly classified the cupping-glass with the agents producing a mixed hyperæmia.

Fig. 11 represents diverse forms of cupping-glasses used by us :[1]

a and *b*, cupping-glasses with fixed rubber ball ; *c*, glass with removable rubber ball ; *d*, shoe-shaped cupping-glass for the reception of pus, also with removable ball ; *e*, cupping-glass with excised margin for a round part of the body ; *f*, cupping-glass for small furuncles of the face ; *g* and *h*, cupping-glass-like suction bells, with glass knee and three-way stopcock for use with suction syringe ; *i*, Muck's suction bottle for the nose and its accessory cavities.

Recently I have resumed some of my old experiments, which have been neglected for years, especially the treatment of painful spondylitis, tuberculosis of the lungs, and coxitis, with large suction apparatus, shaped to suit the appropriate bodily parts, and constructed like cupping-glasses. The pain-relieving influence of these apparatus on the painful spondylitis is very striking, and proves my repeatedly expressed conviction that the cupping-glass has an hyperæmizing effect on the deeper structures.

Other authors have lately designed cupping-glass-like suction apparatus, patterned after our principle, as Prym[2] and Raudnitz[3] for the tonsils, Rudolph[4] and Eversmann[5] for the cervix, etc. Muck[6] replaces the rubber balls with others made of glass, which he has previously rendered free from air by means of a suction syringe. Kuhn has ordered from the firm Evens and Pistor suction bells, which can be made air-tight by turning a removable valve, which can be boiled.

[1] The cupping-glasses are manufactured by Messrs. Eschbaum in Bonn.

[2] Prym, "Über d. Beh. d. entzündl. Erkrankungen d. Tonsillen mittels Saugapparaten" (*Münch. Med. Wochenschrift*, 1905, p. 2318).

[3] Raudnitz, "Zwei neue Saugapparate" (*Prager Med. Wochenschrift*, 1906, No. 34).

[4] Rudolph, "Die Bier'sche Stauung in d. gyn. Praxis" (*Centralblatt f. Gynäkologie*, 1905, p. 1185).

[5] Eversmann, "Die Bier'sche Stauung in der Gynäkologie" (*Centralblatt f. Gynäkologie*, 1905, p. 1467).

[6] Muck, "Ein einfacher und praktischer Apparat für die Bier'sche Stauung" (*Münch. Med. Wochenschrift*, 1906, No. 32).

The rubber ball can be removed and attached to another bell, so that one ball suffices for all apparatus. I have no experience with either of the two appliances.

HYPERÆMIA BY THE AID OF LARGE SUCTION APPARATUS

The most extensive and excellent hyperæmia can be produced in the extremities by means of Junod's boot or an apparatus modelled upon it. Junod's large ventouses and cupping-boots have in their time created considerable stir in the medical world. But they have been almost entirely forgotten, so that now the majority of physicians have no knowledge of their existence. For this reason I deem it advisable to describe somewhat fully these peculiar apparatus, which in my opinion will soon play a rôle in medicine, though in an entirely different manner from that which was intended by their inventor and his imitators. Junod[1] presented his experience and investigations on the applications of rarefied and compressed air to the entire body and individual parts of it to the French Academy of Sciences in the year 1834. In 1838 he[2] described in a second essay improvements in his appliances, and in 1841 sent to the Academy a new report, which consisted mainly of the narration of several cases which had been treated with his apparatus.[3]

Junod's apparatus has been made extensive use of by others, and several contributions on its effect have appeared, among which Ficinus'[4] "The Hæmospesia" is a most complete and detailed monograph. In the following descrip-

[1] Junod, "Recherches physiologiques et thérapeutiques sur les effets de la compression et de la raréfaction de l'air, tant sur le corps que sur les membres isolés" (*Revue Méd. Franç. et Etrang.*, 1834, vol. iii., p. 350; and Report of the Academy, *ibid.*, p. 460).

[2] Junod, "Note sur un nouvel appareil dit grande ventouse propre à faire le vide sur la moitié inférieure des corps, etc." (*Gaz. Méd. de Paris*, 1838, vol. vi., No. 25, p. 388).

[3] Junod, "Nouv. observ. sur l'emploi des appareils hémospasiques et des bains d'air comprimé," read before the Académie des Sciences, Paris, 1843.

[4] Ficinus, "Die Hämospasie. Gesch., Beschr. u. Wirkungen d. grossen Ventousen Junod's od. d. Schröpfstiefels," Leipsic, 1848.

tion I have followed as closely as possible the statements of that physician.

As the large apparatus of Junod, which affects the whole body, as well as those intended for the extremities, for the purpose of driving compressed air into the boot, are of little interest to us, I will limit myself to a description of the suction apparatus formerly well known as "Junod's boot."

At first Junod made four glass and copper cylinders for the four extremities. To insure their being air-tight to extremities of variable thickness, each cylinder at its open end had four attachments of variable width and form. In addition to this, for the purpose of enclosing the air, each attachment was provided with a broad rubber ring which was wound round the extremity by means of a bandage.

The cylinders for the legs had the form of a boot, while those for the arms retained the shape of a cylinder. They were supplied with a manometer and a thermometer. The latter instrument served to register the temperature of warm vapours, which Junod occasionally forced into the apparatus for the production of a more intense hyperæmia. The air in the interior of the apparatus was rarefied by means of a small suction syringe.

Junod has briefly described the effect of his appliances: "If the atmospheric pressure over the extremities is diminished, the skin swells and becomes red, while the extremity soon increases in circumference. The inflowing blood distributes an unusual warmth in it, the activity of the skin is greatly increased, profuse perspiration occurs, excreted moisture evaporates quickly, and deposits itself on the walls of the cylinder. The operation is followed for a little while by a sensation of stiffness and numbness, which, however, soon disappears. If at the same time warm vapours have been used, the effect of the rarefaction of the air is still more pronounced.

"Among general phenomena, one observes a sensation of lightness in the head, the face becomes pale, the pulse of the temporal artery becomes slower, small, and often imperceptible. There appears an inclination to faint. At the same time the respiration is easier, the activity of the intestines is diminished, and nausea develops. Finally, perspiration spreads all over the skin."

The description of these general phenomena shows that Junod made energetic applications of his apparatus, for a large part of the blood was withdrawn from the general circulation.

Later Junod described several improvements in his appliances, which are essentially concerned with the more perfect and convenient air-tight occlusion. He dropped the four attachments, and in their stead applied at the end of the apparatus strips of strong woollen material, which in alternating turns were twisted inwards, so as to ensure the fitting of the apparatus to the extremity; over this he placed a soft rubber cuff, which was drawn over the extremity, firmly attaching itself to it when the air in the interior of the apparatus was rarefied.

Junod[1] published in the year 1843 another essay on the value of hæmospasia. (The term "hæmospasia" was introduced by Bonnard after Ficinus—*αἷμα*, blood, and *σπάω*, I suck.) He asserted that the derivative and revulsive method of treatment had reached an undreamed-of efficiency by means of his apparatus. There is scarcely a disease against which he does not consider hæmospasia indicated and useful. An idea of how much has been treated with this revulsive agent, which has been considered unsurpassable, can be gained from the writings of Ficinus[2] and Jourdan.[3]

Junod from the very first discussed the value of fainting, which could be produced with his apparatus by drawing the blood to the extremities. He states that he had been consulted by surgeons to produce artificial syncope, and it was claimed that during such a stage operations could be undertaken without producing pain, while the reduction of dislocated joints was rendered easy on account of the relaxation of the muscles. He also believed that an artificial syncope may prove advantageous in certain diseases.

It is self-evident that the external pressure of air, when that in the interior of the apparatus has been rarefied, forces the extremity either upwards or deeper into the cylinder. To prevent this, Junod placed in his apparatus partitions and belts against which the foot or hand found a support.

[1] Junod, "Méthode hémospasique," Paris, G. Baillière, 1843.

[2] Ficinus, *loc. cit.*

[3] Jourdan, "Beiträge zur Wirkung der Hämospasie," Inaugural Treatise of the Medical Faculty of Giessen, Mainz, 1848.

It is noteworthy that Junod repeatedly emphasizes the absolute harmlessness of his apparatus. He positively asserts that his boot can be applied even in case of varicose veins, for the appliance dilates only the capillaries, and after being removed the cutaneous veins of the skin are not dilated, but, on the contrary, contracted.

Junod's appliances were soon employed and recommended by several physicians. Erpenbeck[1] in 1838 described an apparatus practically identical with Junod's boot. It was made of tin. The occlusion at the extremity was produced either by a lubricated leather cuff or by various large neck parts which could be slipped over the boot. This apparatus offers nothing essentially new. Erpenbeck, too, considers it merely as a revulsive and derivative agent. He is silent of the fact that Junod has already employed the same apparatus for the same purposes.

In a second essay[2] he describes the experience he gained with his apparatus, and reports as an improvement the production of the air-tight occlusion at the leg by means of an ox-bladder which he tied round the leg and the end of the appliance.

He furthermore describes a very venturesome method of the reduction of a dislocated thigh by means of his apparatus, as follows :

The air is rarefied by means of sucking with the mouth, just as was done by the aborigines with their primitive cupping appliances. Erpenbeck asserts that he had produced with it all the phenomena as cited above in Junod's description, even to the pallor of the face and syncope. This "innovation" could scarcely be looked upon as an advantage.

Ficinus introduced further changes of Junod's apparatus. Like Erpenbeck, he made them of tin because it was cheap, and used a long rubber cuff for the purpose of occlusion, which he fastened to the extremities by means of india-rubber bandages. The other changes concern the suction pump and manometer. As a manometer is not necessary for our

[1] Erpenbeck, "Vorschlag eines neuen Mittels zur Regulierung des Blutlaufs zur Tilgung und Bewirkung von Kongestionen, sowie zur Ergiebigkeit des Aderlasses" (*Caspars W. f. d Ges. Heilkunde*, 1838, p, 373).

[2] Erpenbeck, "Die künstl. Luftverdünnung als Heil- u. Hilfsmittel bei mancherlei inneren u. äusseren Krankheiten" (*Holscher's Hannoversche Annalen*, vol. iv., brochure 3).

apparatus, and a new and improved pump is used, we need not consider these further. It can only be said of the Ficinus apparatus that they scarcely present any improvements over Junod's.

Junod's apparatus and their imitations were made use of according to the ideas then prevalent as revulsive and derivative agents—*i.e.*, it was intended to remove an alleged accumulation of blood from diseased parts to healthy ones. The appliances were regarded as a substitute for the "bindings of the limbs" which had been in use as a revulsive for internal hæmorrhages (especially hæmorrhages of the lungs) since the time of Hippocrates. This method consisted of a very pronounced artificial hyperæmia of the extremities, which was produced by a constricting bandage. Junod's intention is very evident from the words of Magendie, the reporter of the French Academy, who says about Junod's apparatus that every physician should esteem this invention as a great benefaction, for it enables us to combat the congestion of blood to the nobler parts or its exudation into the tissue, and to drive the blood into the extremities without it being permanently withdrawn from the body. Junod himself has given this as the aim of his appliances, and all who made use of them reasoned from the same point of view. This explains the boldness shown in the application of the apparatus, for, as can be seen from the description, they have been used most energetically. They could dare this because the blood was always drawn to healthy parts of the body. Junod himself speaks only of a reddening of the skin and a swelling of the extremity which is treated in his apparatus, but admits that this swelling, which, by the way, appears firm and tough to the touch, remains.

The pictures published by him and Ficinus of extremities so treated prove that the swelling was indeed considerable. The tense fulness remains for several days, and disappears gradually, during which time the skin of the extremity assumes a greenish-yellow and green colour. That is to say, the apparatus was applied so forcibly that it led to extensive hæmorrhages. It is further noted that numerous point-like hæmorrhages appeared at the hair follicles, and red, blue, green, and yellow streaks in the skin.

It is evident from the following contributions to what extent the hæmospasia was practised: Ficinus says that in his apparatus the foot "was squeezed with force against the bottom, to which it was fixed as if glued. Many were afraid that the leg would break under the pressure of the atmosphere." As further consequences, he cites a sensation of numbness, sticking and pricking like flea-bites, intense tension of the skin, especially in the upper half of the extremity inserted in the boot. In the case of an arm, a feeling of weakness and helplessness of the muscles remained in the hand, even on the following day. A large toe once

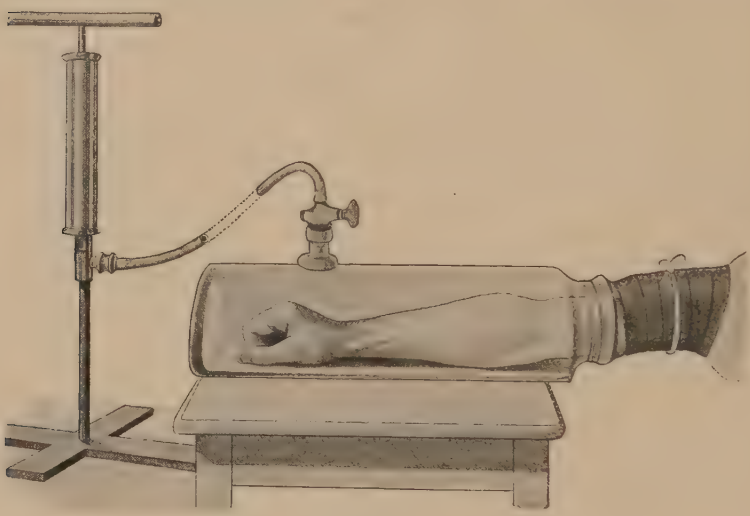

Fig. 12.

retained a sensation like that following a contusion for fourteen days. The rarefaction of the air which proved necessary for the achievement of such an effect amounted to one-seventh to one-third of an atmosphere.

I have imitated and altered Junod's apparatus with a view of producing with them hyperæmia in diseased parts. With this intention the fact that we must, under no circumstances, produce so powerful an effect as is above described is inseparably associated. What is wanted is the production of hyperæmia, but no hæmorrhages; a swelling of the treated parts to be produced which will quickly disappear as soon as

the apparatus is removed, not remain for days. I, therefore, will first give a description of the apparatus now used by me.

For the purpose of producing a pure hyperæmia I make use exclusively of glass apparatus. They have the great advantage of enabling us to observe the colour and swelling of the extremity, and of being easily cleansed ; in addition they are inexpensive. I have ordered all possible forms and sizes of these apparatus in order to produce air-tight occlusion ; a cuff of rubber is slipped over the neck of the vessel. If the cuff, after the extremity has been placed in the vessel, does not fit perfectly at once, it is firmly attached by means of the rubber bandage to the extremity, but not so strongly as to itself produce a congestion hyperæmia of the part of

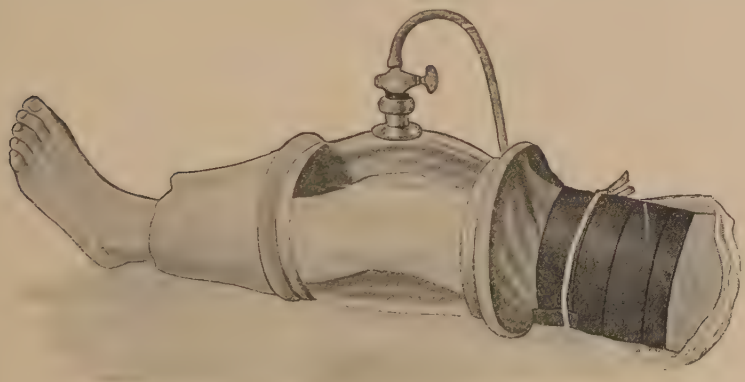

Fig. 13.

the extremity in the apparatus. One easily learns to secure air-tight occlusion in the desired manner.

Next, the air in the apparatus is rarefied by means of the suction pump. For that purpose the small pump made by Junod can be used, but I prefer the larger pump on a stand used by the bicycle dealers for inflating rubber tyres, with the difference that the position of the valve is reversed, so that the pressure pump is turned into a suction pump. (See Figs. 12 and 13, representing old models, to illustrate the principle.)

As can be seen in the illustration, the pump is connected with the glass vessel by a piece of rubber tubing. Connection is made with a rubber cork, which fits air-tight in the escape

opening of the vessel. The cork is perforated by a stopcock, which can be opened and closed at will.

The treatment of the diseased extremity proceeds as follows : The air is rarefied to a degree which can be tolerated by the patient without special discomfort. In addition, the degree of the produced hyperæmia must be observed through the glass. After the desired intensity has been reached, it is maintained at that height for a few minutes by closing the stopcock, or, if the outlet (as occasionally occurs) is not air-tight, by continuing to pump slowly. Then the stopcock is opened to permit the ingress of air. After an intermission of twenty seconds to three minutes, the hyperæmia is reproduced by renewed pumping, and in this manner the procedure is repeated for from twenty to thirty minutes.

The external pressure of the air forces the rubber cuff into the apparatus like a wind-struck sail, and the extremity is forced into the vessel at the same time If the nature of the disease is such that we wish to avoid pressure against the walls of the vessel, the patient must try to pull back the extremity, holding on to the apparatus, and pulling in the opposite direction. I make use of these vessels for the leg and arm up to the region of the hip and shoulder joints. For both of these joints we have not yet made suction apparatus. The difficulties connected therewith are not necessarily insurmountable. Any part from the middle of the upper arm and thigh, down to the points of the fingers and toes, can be rendered hyperæmic in these vessels. Certainly, if one desires to treat the knee-joint, for example, the entire leg and foot are also rendered hyperæmic, though they are not in need of it ; but on account of the short duration and moderate intensity of the hyperæmia this does not matter : fainting or similar inconveniences are not caused thereby. If one desires to limit the hyperæmia, the peripheral part of the extremity can be firmly bandaged with a roller bandage. One must be careful not to rarefy the air to such an extent that the margins of the bandage cut into the skin and produce extravasation of blood. But so intense a rarefaction of the air is never reached for our purpose, and therefore needs no comment ; besides, the bandaging is only exceptionally indicated.

For the purpose of rendering limited parts of the ex-

tremity hyperæmic, I have ordered glass vessels to be made, which are open at both ends, supplied with a rubber cuff each. Such an apparatus for the knee can be easily appreciated, without any further description, from the illustration shown in Fig. 13.[1] Owing to the fact that the rarefaction of the air draws in the extremity from above and below, the joints in these apparatus are curved.

In a similar manner such suction apparatus can be made for any part of the limbs below the hip and shoulder joints As a general rule, however, they can be dispensed with, because they render the entire apparatus too complicated. The double air-tight occlusion is very difficult to attain. On the other hand, they are very useful for orthopædic purposes, to which I shall refer later on.

If the walls of the vessel have been rubbed with soap-powder before the treatment, the changes which take place in the treated extremity can be observed through the glass. Otherwise the evaporated water from the limb becomes deposited, making the observation difficult. As a rule, in the first applications one does not obtain the high degree of hyperæmia which can be produced with ease after repeated use of the apparatus.

If the rubber bandage, with which the air-tight occlusion of the rubber cuff is secured, has not been applied so firmly as to itself produce a congestion hyperæmia, the limb in the apparatus has its normal colour before the air is rarefied. After a few suctions with the pump the limb begins to swell a little, and assumes a gradually increasing red hue. Very frequently, with each sucking of the air, one can observe a moisture emanating from the limb, though frequently this does not occur. As a rule, the interior of the vessel becomes cloudy with moisture, occasionally so much so that water-drops are formed, and the glass cannot be used for the observation of the part treated.

When the air is still further rarefied, the bright red skin shows blue streaks, or the entire skin assumes a bluish discoloration with numerous vermilion spots, such as we have become acquainted with in intense congestion hyperæmia produced by a bandage.

[1] In the illustration the upper rubber cuff only is bandaged by a rubber bandage ; the lower cuff is loose, so as to show it plainly.

The oftener the apparatus is applied, the more magnificent the hyperæmia. It becomes especially intense in tuberculous limbs, which occasionally assume entirely different forms on account of circumscribed swellings. The increase in volume of the extremities can become so great that the limb can only be pulled out with great difficulty from the vessel in which it has been subjected to the atmospheric pressure induced by forcing air through the narrow neck of the vessel. If the air is rarefied very much, the hair follicles are sucked out so that the extremity acquires a "goose-skin." The effect of rarefied air on open ulcers and fistulæ will be discussed later, when we take up the effect of the apparatus on open tuberculosis.

Intense thinning of the air produces point-like hæmorrhages and numerous vermilion spots, even in the normal skin.

The patient states that the skin becomes tense, occasionally so much so that he fears it will burst. In the limb there is an itching and prickling sensation, "as if one were treated with electricity." On intense rarefaction of the air, the joints, especially the wrist, begin to be painful, and one has a sensation as if the ends of the joints were forcibly pulled apart.

In a hyperæmic limb a sensation of increased warmth develops, which is often maintained hours after the treatment. Objectively an increase in the temperature of the skin can be demonstrated.

Individuals who suffer from chronic rheumatism state that the diseased joints in which they always experience a sensation of cold become warm, and remain so during the intervals. Considerable increase in the temperature of the skin is especially observed in tuberculous joints which are subjected to treatment.

One can therefore see that dilatation of the bloodvessels has a prolonged after-effect.

The most intense degrees of hyperæmia, as above mentioned, must never be produced with a suction apparatus in diseased parts of the extremities, unless we have to deal with stiff joints, the cause of the disease of which has already disappeared, for we are apt to do more harm than good. The appearance of hæmorrhages in the tissues, and of too large a number of vermilion spots, which are always the sign of considerable disturbance of circulation, must be avoided.

A few of these spots, however, will be regularly observed when a severe application of the apparatus is made.

It is of importance to decide which form of hyperæmia we really produce with these suction apparatus. Undoubtedly the rarefaction of the air acts, in the first place, by dilating the capillaries, because they have the most yielding walls, and in the second place on the veins. The arteries, with their strong elastic walls, in all probability are but little influenced. If this be accepted as correct, one would surmise on first thought, that with the same influx a dilatation of the bed of the current would necessarily produce slowing of the circulation. I have already explained in my contributions repeatedly mentioned, on the development of the collateral circulation, that this apparently clear and logical conclusion—physically speaking—is misleading for the conditions of the living body. Experience shows us, on the contrary, that dilatation of a certain capillary region is associated with a decided increase of the rapidity of the circulation in the concerned region. The diminished resistance to the circulation caused by the dilatation is so enormous that the slowing effect of the dilated current-bed is of no importance whatever. In general, one can therefore say, local dilatation of a certain region of capillaries is associated with a decided acceleration of the circulation, provided the activity of the heart remains the same, a fact which, incidentally speaking, overthrows a whole series of theoretically constructed hypotheses of many hydrotherapeutists.

Nevertheless, there is no doubt that the suction apparatus, even if used in moderation, produces in the majority of instances a congestion hyperæmia, as can be seen from the above description. The reason for this congestion hyperæmia is the impediment to the venous return flow. As soon as the air in the interior of the apparatus is rarefied, the external atmospheric pressure strongly forces the occluding cuff against the limb. This is still more increased when the cuff is bandaged with a rubber bandage. Both have identically the same effect as the congesting rubber bandage. From the entire description which we have given above on the effect of Junod's apparatus, it is evident that those old physicians have produced with the appliance congestion hyperæmia of the highest degree.

The following experiment made on myself proves that with a certain degree of rarefaction of the air in these apparatus an undoubtedly arterial hyperæmia can be produced, which must be regarded as a consequence of the lessening of the resistance in the capillaries. I place my arm in a glass suction apparatus, and fasten the occluding cuff with a rubber bandage. It appears that this alone produces a slight congestion hyperæmia in the extremity. Increased rarefaction of the air produces a dark hyperæmia of the skin, the superficial veins swell, while a sensation of itching and prickling appears in the limbs. Gradually the background, the blue colour of the skin, shows the vermilion spots, known to us from the hyperæmia produced by a bandage. Additional rarefaction of the air intensifies also all these phenomena. The limb swells and "sweats" considerably.[1] It gives the impression of the blood being totally stopped in the swollen limb. That this is really the case is proven by the pronounced reactive arterial hyperæmia of the extremity, which occurs twenty minutes after its removal from the apparatus. For this reactive hyperæmia is in intensity and duration the most sensitive measure of the impoverishment of oxygen of an external bodily part, as I have already shown in detail in some of my earlier contributions.

I now place the still arterially red arm in the apparatus, fasten the cuff less tightly with the rubber bandage, and rarefy the air but little. A very intense bright red hyperæmia appears, and I have in my limb a sensation of intense warmth. The arm "sweats" very much, so that the walls of the glass vessel become thickly covered with water, and I have the sensation of the limb being in a moist warm atmosphere. This hyperæmia, which is evidently a pure arterial one, can be conveniently maintained for twenty minutes after the experiment is stopped. Because one can produce, with the suction apparatus, either active or passive hyperæmia, I have previously classified the hyperæmia produced by them as mixed. I admit that this term was not a happy choice.

These apparatus will prove of value in many diseases which are suitable for treatment by hyperæmia. The

[1] I use the term "sweat" for the pronounced evaporation of liquid in the suction apparatus for the sake of brevity, and leave it undecided whether we have to deal with a real sweating or increased transpiration.

application to the diverse diseases will be discussed in the clinical part of this work.

I have made use of these suction apparatus for the purpose of producing hyperæmia for over eleven years, but could not recommend them for general use heretofore, because they had important defects, which, in spite of many efforts, could not be overcome by the technical resources at my command while I lived in Kiel and Greifswald. Since my removal to Bonn I have met Carl Eschbaum, a technician who has so improved the apparatus that they now work perfectly.

The suction apparatus has acquired another importance in so far as I make use of the air-pressure to bend and extend stiffened joints. I believe that with this application of air-pressure I have introduced a fruitful principle in orthopædics, which could be extended with advantage in various directions. These apparatus, which have to bear the force of the atmosphere, require solid construction, strong glass walls, and strong rubber cuffs, the wall strength of which for larger apparatus must be from 4 to 6 millimetres. The cuff consists of three parts—the occluding part, which ensures air-tight attachment to the apparatus ; the cuff which surrounds the extremity, and the circumference of which is made to correspond with that of the various limbs ; and a funnel-like part between the two, the material of which must be very yielding in order to be able to react to the air-pressure. The latest apparatus has rubber cuffs, which are so arranged that they can be removed and reapplied with a few manipulations, thus enabling one to easily cleanse the interior and to insert suitable auxiliary appliances.

If a limb—*e.g.*, an arm—is placed in such a suction apparatus, and the air therein is rarefied, the external air-pressure presses the hand with steadily increasing force into the glass vessel, finally driving it with irresistible force against the bottom. This powerful force is taken advantage of by us for the mobilization of stiffened joints. A description of the apparatus for the hand, which in practice is the most important and technically the best executed, will give us a clear idea of the procedure.[1]

[1] A more detailed description of my apparatus is found in Bier, "Über einige Verbesserungen hyperämisierender Apparate" (*Münch. Med. Wochenschrift*, 1904, No. 6).

1. *Flexion of the Wrist.*—A cushion, 5 centimetres thick, made of finely sewed horsefelt, enclosed in a leatherette cover, is placed in the apparatus (as shown in Fig. 14). To ensure its remaining firm, it is placed in a half-spout made of tin, which is also covered with leatherette. The patient pushes the spout against the bottom of the vessel with the diseased hand, and places therein the pillow. If the hand is very stiff, this is done by the physician.

The cuff is fastened to the forearm in the manner above described, while the fingers are closed as much as possible into a fist ; the patient presses the back of the first finger-joints and metacarpo-phalangeal joints against the cushion. and flexes the wrist as much as the stiffness will permit. The

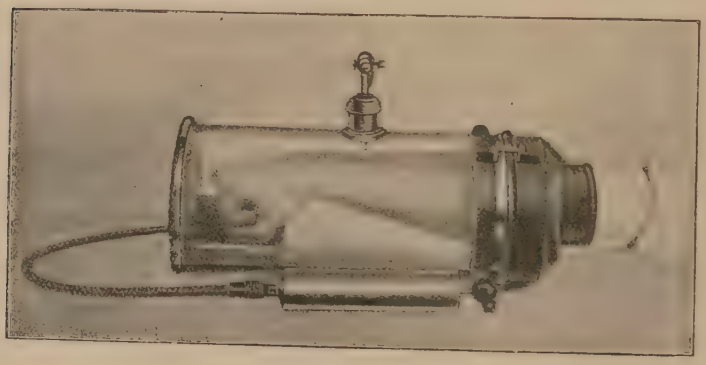

Fig. 14.

stopcock is closed, and the air in the apparatus intensely rarefied. The air-pressure squeezes the limb into the apparatus with great force and bends the wrist When the air is very much rarefied, the patient is absolutely unable, in spite of all efforts, to remove the hand from the cushion, or to extend the wrist, such is the force with which the limb is driven against the cushion on the bottom of the vessel.

2. *Flexion of the Phalango-Metacarpal Joints of the Four Last Fingers* (see Fig. 14).—The wrist is placed in median position at first, the phalanges are flexed as much as possible, the lower half is pressed against the cushion, while the thumb extends above it. By rarefying the air the joints are bent as strongly as the patient can endure without considerable discomfort.

3. *Flexion of the Thumb in the Phalango-Metacarpal Joint.*—The four last fingers catch over the cushion, the thumb is bent into the palm as much as the stiffness permits, pressed against the cushion, and the flexion is procured by the rarefaction of the air. Flexion of the other small finger-joints requires no description. One will fully appreciate it after trying it on one's own hand. I only wish to add that flexion of the second and third finger-joints becomes more extensive when the wrist is extended as much as possible. Of course, any individual finger and any stiff joint can be successfully bent in the apparatus.

4. *Extension of the Wrist* (illustrated in Fig. 15).—A metal plate of about the same size as the glass bottom carries four

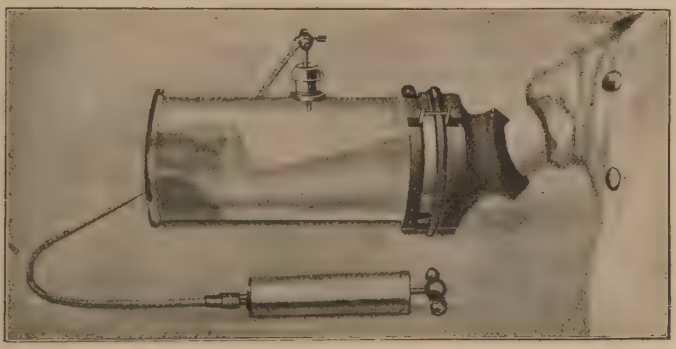

Fig. 15.

side-supports facing the opening of the vessel to prevent toppling against it. The two upper supports have excisions which serve to receive a wooden handle. The patient grasps the handle in the fist, places its axles in the position of the upper supports, forces it against the bottom of the vessel, and extends the wrist as far as the stiffness will permit. Further extension is produced by the rarefaction of the air.

A glance at Figs. 14 and 15 will clearly illustrate the application of the apparatus.

Instead of the cushion and crutch as a counter-support for the hand, I make use of an inflated soft rubber cushion, which replaces both, and is less painful for the sensitive fingers and hands.

The patient is as much as possible to actively co-operate

in all these passive movements. Above all, he must not try to fight spasmodically by active extension against the attempt to flex a joint.

The physician who makes use of suction apparatus should first try everything on his own limbs. It is easy to calculate for each individual apparatus the force of atmospheric pressure with which the extremity is driven into the cylinder. By attaching a manometer to the glass vessel it can be determined for any desired degree of rarefaction. In order to be convinced what powerful orthopædic force we have at our disposal, a trial on one's own extremity is much better than any such calculations. And what is most noteworthy is that the painfully stiff joints generally tolerate this considerable force. To a great extent this is due to the hyperæmia either preceding or accompanying the suction, which lessens the painfulness and the contractures, while rendering the connective-tissue parts more supple through swelling and serous infiltration. For this reason I regularly render the hand hyperæmic by rarefaction of the air, before attempting motions and stretching. After the forcible stretching and bending, hyperæmia is again applied, during which the patient continually executes active motions. Again, no force acts as evenly and delicately as air-pressure, which can be regulated to any desired quantity and applied in any manner.

Sudeck has taught us that even in stiff joints after injuries and inflammation considerable atrophy and softening of the bones takes place. For this reason I was at first afraid that in joints diseased by trauma and rheumatism the great force of the rarefaction of the air might lead to the destruction of the bones. But in spite of frequent applications to stiff wrist and finger joints, I have never seen any damage done. Evidently the specific structures of these soft bones can stand more in a living condition than one would believe.

To be sure, a tuberculous joint at the height of disease must never be subjected to this treatment. With considerable rarefaction of the air, the pressure is so enormous that undoubtedly the softened carpal bones would be contused and shattered. For this reason I use *this orthopædic treatment almost exclusively for joints stiffened by trauma and rheumatism*. Only such tuberculous stiff joints, in which the

tubercular process has subsided, are treated in this manner for the purpose of overcoming the stiffness. An exception to this is a tubercular knee-joint in a flexed position. These we have treated, when they were still affected, in an extension apparatus constructed by Klapp (see Fig. 17) in a very delicate manner.

The suction apparatus unites two very powerful remedial agents. It produces hyperæmia, which, as I shall later on explain, is an excellent solvent for stiffening, and which replaces, or rather excels, our medico-mechanical appliances, for with it we can apply much greater force more delicately. For the finger-joints we have so far lacked an instrument free from objection. The usual pendulum and similar apparatus are unable to grasp the small finger-joints.

Several men capable of judging, whose hands have been treated first in the pendulum apparatus and then in the suction apparatus, have assured me that the latter is not only more effective, but also much more convenient and more delicate. The hand apparatus had the disadvantage that pronation and supination could not be undertaken with it. Fränkel[1] has overcome this by so fastening the hand that, when driven into the vessel by the air-pressure, it was bound to follow a spiral-like plane inserted in the apparatus, which could be arranged for supination and pronation.

Fränkel made the apparatus more useful also for the other motions by prescribing for the joints of the hand their movements which they had to follow during the pressure of the atmosphere, on account of previous fixation.

Klapp obtained pronation and supination in a very simple and ingenious manner. He got C. Eschbaum to make a hollow cylinder for the suction glass which is supplied with rifles, somewhat like those in rifle-barrels. At one end these rifles run from right to left for pronation, at the other end in the opposite direction for supination. A handle, which can be placed anywhere in the rifles, serves as a grip for the hand. The air-pressure which drives the hand into the suction apparatus produces in this manner either pronation or supination, depending on the original position. In

[1] Fränkel, "Eine Verbesserung der Bier'schen Saugapparate," address delivered at the Free Union of Surgeons, Berlin, May 8, 1905; and "Zur Behandlung von Handversteifungen mit dem Bier'schen Saugapparat" (*Zeitschr. f. Diät. u. Physik. Ther.*, vol. ix., No. 10).

order to render the stiffened ankle-joint at once hyperæmic and mobile, I make use of a very strong glass boot with spacious foot-end. A sole-like piece of sheet-iron covered with leather or leatherette is placed against the bottom of the boot. This sole has on its heel-end a half-spout into which is placed a narrow, high, and stiff cushion. The cushion can also be fastened by means of a button to the toe end of the sole.

If it is desired to stretch the foot, it is pressed with the toes against the cushion hung over the metal sole. If it is desired to flex it, or the foot, the posterior part of the heel is placed on the pillow in the half-spout of sheet-iron, and then the air is rarefied. Extension of the foot takes place as the air in the apparatus is very much thinned, especially when the above-

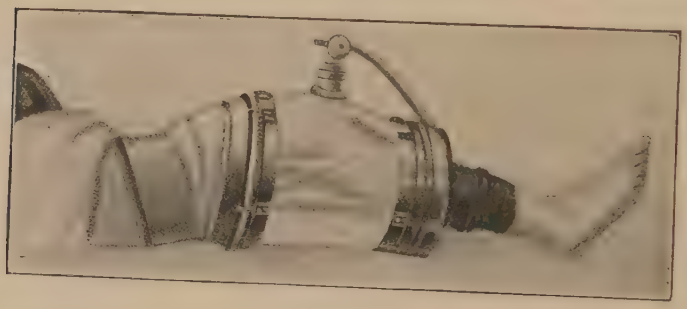

Fig. 16.

described heavy rubber cuff is made use of, on account of the long lever formed by the foot. In experiments on my own foot, I had the sensation that the plantar fasciæ were stretched to bursting, and that the arch of the foot was entirely flattened. In spite of the short lever of the heel, we can nevertheless make use of great force by inducing flexion.

For bending the knee and elbow joints, I now use an apparatus a type of which is represented in Fig. 16.

I place the knee, which is stiffened in an approximately extended position, in a barrel-shaped glass tube 31 centimetres long, and open at both ends, the upper surface of which is so bent that the middle of the hump is situated during the activity of the apparatus over the knee-joint; this gives the limb abundant space. The tube has, at its

upper part, a wide cuff for the thigh, and at the lower end, for the leg, a narrow strong cuff. In order to arrange the apparatus, the patient puts the foot through the upper wide cuff; the physician, meeting him with the hand from below, takes hold of the extended foot at the toes and pulls it through the lower cuff while the patient is sliding the upper cuff over the thigh. The lower cuff is fastened to the leg by means of a rubber bandage; the upper one, as a rule, fits without any further help. Rarefaction of the air bends the knee-joint with great force, because the air-pressure acts upon both sides.

Occasionally, if the apparatus has a powerful effect, the lower cuff presses so hard against a thin bone as to produce violent pain. This can be easily avoided by folding in the cuff, and by placing around the limb a soft strip of felt, 10 centimetres wide, in such a manner that when the cuff is adjusted the greater part of the felt lies beneath it, and about one-fourth of the width protrudes. The occluding end of the cuff and the protruding end of the felt are then fastened to the limb by means of a rubber bandage.

After the treatment the apparatus is removed in the following manner: The patient places both hands beneath the upper cuff and raises it, while a second person takes hold of the vessel and removes it like a boot; the lower cuff turns inwards and follows by itself.

The apparatus illustrated in Fig. 16 is intended only for the gradual bending of stiff knees. If one desires to bend somewhat movable knee-joints, this apparatus does not offer ample space, and is to be replaced by another one having the form of an acute angle, in which the introduced leg is compelled to assume the greatest possible flexion at the very beginning of suction.

The acute-angled bending apparatus are made of metal. A small window attached on each side enables us to observe the extremity treated.

In my first publication, I myself declared my apparatus to be very imperfect. They were then only to represent the principle of a union between the effects of mobilization and hyperæmia. Thus, for instance, they could not be used for stretching in the position of flexion and for bending in the position of straight extension of completely stiffened ex-

tremities. I am aware that it will require difficult technique and ingenious appliances to make them serviceable for all movements, but I do not doubt that we shall finally be successful. Considerable progress in this line has already been made. It is principally due to Klapp[1] that several imperfections have been removed. The description of two of his apparatus will plainly illustrate their principle. Fig. 17 represents a large tin box for the purpose of stretching curved knees. This apparatus is supplied with a rubber cuff for holding and occluding the thigh, similar to the one seen in my appliances. Over the place where the curved joint is to be placed we observe a large opening. A wide rubber air-tight bag (*g*) is inserted. When the air in the tin box

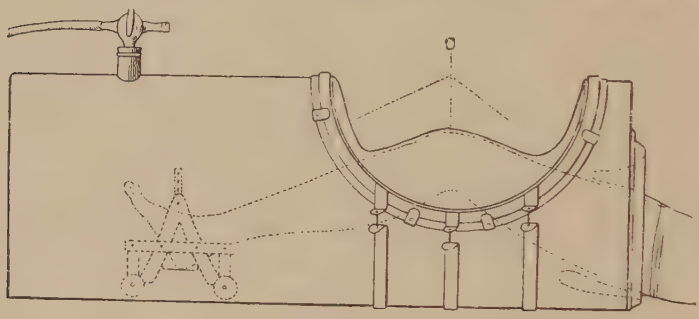

Fig. 17.

is rarefied, the knee is compelled to extend through the pressure of the rubber bag. At the same time the occluding cuff draws itself in, but this force is too slight for the amount of air rarefaction required in this apparatus to overcome the friction of the heavy box and the sitting body of the patient.

The box must be long, so that the foot does not push against the bottom, for, in stretching, the foot must naturally slide forward. To facilitate this, an upholstered little roller is placed beneath the heel. As the pressing force is in proportion to the surface of the rubber bag, the stretching is accomplished with tremendous force on account of its large expansion. On the same principle, Klapp succeeded in mobilizing a wrist, completely stiffened in a straight position, to such an extent that the ordinary apparatus for the

[1] Klapp, "Mobilisierung versteifter und Streckung kontrakturierter Gelenke durch Saugapparate" (*Münch. Med. Wochenschrift*, 1905, No. 17).

hand above described could be made to successfully take hold of the wrist. Again a tin box with rubber cuff and upper opening is applied. Depending whether bending or stretching is intended, the lower space is placed either with the flexion or extension side on the upholstered splint (*s*)—see Fig. 18—which reaches only to the wrist-joint. The rubber bag (*g*) is drawn inwards as soon as the air is rarefied, places itself against the hand, and produces accordingly bending or stretching. The bag, by a peculiar arrangement, is so constructed that it continually follows the movements of the hand.

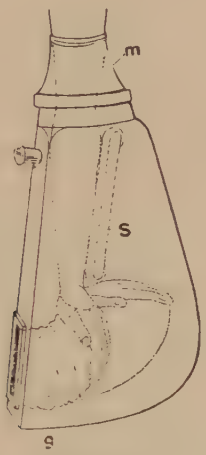

Fig. 18.

At first one might come to the conclusion that the rubber bag is not practicable, because through its pressure it produces anæmia of the affected joint. Riper study, however, shows that the very parts of the extremity which are to be stretched are not at all concerned in the pressure of the bag, but are rendered intensely hyperæmic by the thinning of the air—as, for example, the shrunk soft parts of the popliteal space in curved knee-joints.

Schmieden[1] has constructed a large suction apparatus of glass for the purpose of producing hyperæmia of the entire head; this appliance, which is fastened to the neck by means of a cuff, functions very well. Rarefaction of the air

[1] Schmieden, "Ein neuer Apparat zur Hyperämiebehandlung des Kopfes" (*Münch. Med. Wochenschrift*, 1906, No. 31).

is accomplished by pumps like those illustrated in Figs. 12, 13, 14 and 15.

In our surgical clinic, where suction apparatus are made use of extensively, we have a very large suction and pressure pump supplied with a fly-wheel, sixty revolutions of which draw out 90 litres of air. This pump is connected with all larger suction apparatus by rubber tubing and stopcocks, which are regulated by an attendant, who is able to maintain in action a whole number of appliances at the same time. By varying the position of the stopcocks the pressure of the air in the individual apparatus can be exactly regulated.

The value of this suction pump is that it is so constructed that the sucked-up air can be given off into another apparatus, the condensed air of which I use for pressure purposes—*e.g.*, pressing away of œdema.[1] The use of suction apparatus for traumatic stiffening has so greatly increased with us that I intend to equip a motor which will rarefy the air in a large vacuum container to which a large number of apparatus can be attached. By regulating the position of the stopcocks, one could then slowly, carefully, and evenly, thin the air in the apparatus. The thinning of the air with pumps has this disadvantage, that they all act in jerks.

Figs. 14 and 15 represent the best suction apparatus for the hand. It rests on an iron base, alongside of which the patient is conveniently seated. A hand suction pump can be attached at the right and left side of the base, which the patient himself can attend to with his healthy hand, if for special reasons another individual cannot attend to that.

OTHER AGENTS FOR THE PRODUCTION OF HYPERÆMIA, ESPECIALLY CHEMIC "DERIVANTIA"

For thousands of years the so-called skin irritants have been used as remedies for all possible affections. Although at times they have been employed more or less extensively, they have never been entirely abandoned, and even to-day, when their effect is much disputed, many physicians make

[1] These apparatus will be described by me elsewhere.

use of them, and they are also popular family remedies. The skin irritants are divided into rubefacientia (reddening), vesicantia and pustulantia (producing blisters and pustules), and suppurantia (tissue-destroying and pus-producing). From among the large number of such remedies, I mention iodine, alcohol, opodeldoc, tincture of arnica, turpentine, pitch, tar, Spanish fly, croton-oil, tartarus stibiatus, silver nitrate, strong alkalis, strong acids. The very old view, that these agents draw morbid serum from the diseased parts, has retained its hold to this day. Of late, however, it is the blood which is considered to have accumulated in too great a quantity or in a morbid condition in the affected parts, the end in view being to divert it to healthy parts, in order favourably to influence the diseased areas. For this reason these agents were named derivantia or revulsiva—deviating agents. For centuries—even Hippocrates and Galen made this distinction—a derivans was the name given to an agent which would deviate morbid serum or stagnant blood into the immediate vicinity, while those which led them toward remote parts were designated as revulsiva. If the skin over a diseased wrist-joint is painted with iodine, it is a derivans. If, however, a mustard plaster is applied to the calf of the leg for inflammation of the lungs, we speak of a revulsivum. It is noteworthy that the literature on these old remedies, the age and dissemination of which over the entire earth, and with all peoples, by far exceeds that of cupping, is surprisingly meagre, and few physicians have taken the trouble to explain physiologically their therapeutic action. I will cite briefly the most important contributions on this subject which I have been able to find.[1] We shall first discuss the revulsion, which plays such a great rôle in hydrotherapy, though under a different name. This point, it seems to me, is important for a better understanding of the subject-matter, although in this work we are more concerned with local than distant effects.

Naumann[2] was the first to study revulsion in the sense of diversion of blood and morbid serum. He made the fol-

[1] Compare Plaskuda, "Einige alte Behandlungsmethoden in moderner Beleuchtung," Inaug. Diss., Greifswald, 1903.

[2] Naumann, "Unters. über d. physiol. Wirkungen d. Hautreizmittel (Epispastica)" (*Prager Vierteljahrsschr. f. d. Prakt. Heilk.*, vol. xx., 1863, p. 1).

lowing experiment: He amputated one of the hind-legs of a frog, leaving the sciatic nerve intact after the animal was killed, by severing the spinal column from the head, thus avoiding loss of blood. The extremity was, therefore, connected with the rest of the body only by the sciatic nerve. When Naumann stimulated this leg with the faradic current on any desired place, he found this agent to have an intense effect on circulation of the blood, no matter whether he observed under the microscope the mesentery, the lungs, or the web. Weak stimulation produced an acceleration of the blood-current and increased activity of the heart; strong stimulation resulted in a diminution of the blood-current and weaker activity of the heart. Similar results were obtained by him when he made the experiment on warm-blooded animals (bats), the blood-circulation of which he observed in the wing membrane. Other skin irritants had the same effects.

Naumann also made experiments on living human beings, the proof of which, according to our modern knowledge of physiology, avails us little. For this reason I will omit them. Naumann drew from these experiments the conclusion that a hyperæmia accompanying the irritation of the skin need not be considered, and that a diversion of blood from deeper to superficial parts, as was generally accepted, does not exist. The curative effect of the epispastics is produced, by means of the central nervous system, by reflex action. For this reason the place of irritation is of no moment, and the success of the agents depends on the intensity of the cutaneous irritation, in so far as weak stimuli increase the activity of the heart and bloodvessels in the entire body, while strong stimuli diminish it. These observations were dwelt on more fully by Naumann in later contributions.[1] He found that the changes produced by a prolonged application of a skin irritant remain for some time after the cessation of the irritation. He furthermore asserts that the skin irritants influence the bodily temperature, which point we may here omit as of no interest to us.

Schüller[2] also contributes an article on revulsion by skin

[1] Naumann, *Prager Vierteljahrsschr.*, 1867, and "Zur Lehre v. d. Reflexreizen u. deren Wirkung (*Pflüger's Archiv*, vol. v., 1872)

[2] Schüller, "Über die Einwirkung einiger Arzneimittel auf die Gehirngefässe" (*Berliner Klin. Wochenschrift*, 1874, p. 294).

irritants. He trephined rabbits, and observed the vessels of the pia through the uninjured dura mater. On covering the largest portion of the abdomen or back of the animals with mustard plaster, he observed, apart from some other changes which do not interest us, that the arteries dilated regularly in the beginning of the action of the agents. For ten minutes the vessels varied in their calibre, contracting afterwards, and remaining lastingly in such a condition. The entire brain shrank. The mustard remained on half an hour, and was then washed off ; but even after its removal the vessels remained contracted for one and a half hours. During this condition so powerful a remedy as the inhalation of amyl nitrate produced with difficulty and in a less degree a dilatation of the contracted vessels than that accepted as normal. Schüller is of the opinion that these phenomena are neither due to a reflex stimulation of the vessels of the brain alone nor to the "depleting" effect of the mustard plaster alone. He believes that in the beginning of the effect of the remedy a paralysis of the vaso-motor nerve fibres is produced by reflex from the skin, which causes the moderate dilatation of the vessels. If the effect of the mustard-oil is continued, the intense hyperæmia developed and the œdema of the skin diminish the lateral pressure in the rest of the circulatory apparatus, or at least diminish the relative quantity of blood in it, therefore being also able to diminish the volume of blood in the brain vessels. Schüller does not wish to exclude reflex action of the oil even in the later stages of its activity.

On the whole, Schüller explains the effect of the mustard plaster by revulsion in the sense used by the old physicians. In the same year appeared a larger contribution by the same author,[1] in which he considered the effects of the employment of water on the skin, which can be considered here only in so far as both cold and heat are among the stimuli of the skin. The result obtained by Schüller, briefly related, is as follows : Application of cold water to distant parts of the skin produces a dilatation, that of warm water a contraction, of the vessels of the pia. Schüller believes that

[1] Schüller, "Experimentalstudien über d. Veränderungen d. Hirngefässe unter d. Einflusse aüsserer Wasserapplikationen" (*Deutsches Archiv f. Klin. Med.*, vol. xiv., 1874, p. 566).

reflex influences of the cutaneous nerves play but a secondary rôle in this, and that, if anything, they prove an obstacle. The changes in the brain vessels he believes to be essentially due to contraction or dilatation of the circulatory apparatus in the skin.

I can pass over the practical conclusions which Schüller has drawn from his experiments for hydrotherapy, as they do not belong here. Schüller's experiments in hydrotherapy play a great rôle. His experiments have been utilized for the explanation of certain effects of water, and certain laws for the application of water are based on them. Winternitz[1] mentions them with praise, and believes himself able to prove their correctness with plethysmographic experiments, showing the influence of the quantity of blood of one bodily part on another through the action of heat and cold.

Matthes[2] considers Schüller's experiments as of little value. He says that they are so uncertain "that this kind of physiological experimentation scarcely deserves to be considered as a scientific observation."

To this may be added the experiments of François Franck, described on p. 20, which also have been used for the explanation of the curative effects of water. I can pass this over, as I have already recited my scruples about the value of these experiments, for they lead to contradictory views on the local effect of heat.

Taken all in all, we can see that even to-day the remote effects of stimuli, cold and heat included, are not established scientifically, and that we are compelled to rely solely on experience. In this respect we are not any farther on than were the old physicians, with their views on venesection, and Junod's hæmospasia, and finally we come back to the old theory of revulsion, which appears here in a modern dress. While before the change in the distribution of blood was mechanically explained, we try to account for these phenomena by attributing them to vaso-motor influences.

This uncertainty of explanation is well represented by Samuel's[3] noteworthy experiments, which must be mentioned

[1] Winternitz, "Die Hydrotherapie auf physiol. u. klin. Grundlage," second edition, vol. i., pp. 109-116.

[2] Matthes, "Lehrbuch der klinischen Hydrotherapie," Jena, 1900, p. 31.

[3] Samuel, "Zur Antiphlogose" (*Virchow's Archiv*, vol. cxxvii., p. 457).

here. This physician showed that croton-oil applied to the ear of a rabbit produces no inflammation as long as the other ear, or even the extremities, are kept immersed in cold (below 15° C.) water. Samuel was able to avoid inflammation for twelve hours, and even after the removal of the rabbit from the water he found that the inflammation was less intense than under normal conditions. If he made use of scalding instead of croton-oil, he could not suppress the phenomena of inflammation by means of cooling, but they were less pronounced.

If we could interpret the absence of inflammation as a reflex effect, we could comprehend these experiments. But Samuel himself proved that this is not the case, for he obtained the same phenomena when he cut through the sympathicus on the crotonized ear and the nervus auricularis major and minor on the one subjected to cold. These noteworthy facts are so far entirely unexplained.

While it is easy to understand that the interpretation of the remote effect of skin stimuli is extremely uncertain—because we are so little familiar with the concerned physiological conditions—one would imagine that the local effect of these remedies has been studied thoroughly, and that there can exist no difference of opinion in regard to the changes objectively perceptible in the region of the application. But this is not the case. The experiments undertaken for the investigation of the old doctrine of revulsion are extremely meagre, and the individual results contradict each other to a great extent.

Zülzer,[1] contrary to Naumann, accepts the theory of a simple derivation of the blood by mechanical causes from deep to superficial parts, when the latter are subjected to skin stimuli. He concludes this from the following experiment repeatedly tried :

For fourteen days the shaved back of a rabbit was daily painted with cantharidin collodium. On section the skin on the affected side suppurated and cicatrized, the blood-vessels below the skin greatly dilated and filled with blood. Subcutaneous fat disappeared. The superficial muscles were considerably hyperæmic, containing hæmorrhagic

[1] Zülzer, "Über die Wirkung der ableitenden Mittel (Derivantia)" (*Deutsche Klinik*, vol. xvii., 1865, p. 127).

places. The deeper muscles, however, were extremely pale, as compared with those of the healthy side, as were also those of the chest wall, on the inner surface of which the difference was still more prominent. The striking diminution in the blood-volume extended to the musculature of the thigh. On frequent repetition of the experiment, even the lung of the affected side appeared strongly anæmic, as compared with that of the healthy side. In the vicinity of a seton he found similar conditions, superficially hyperæmia, more deeply anæmia.

Schüller[1] found the skin, including the areolar tissue, of rabbits which he had treated with mustard plaster hyperæmic and very much swollen, and reduced "to a tough, jelly-like mass." The deeper parts he does not mention, but he states that small mustard plasters which he applied to the ear and back of the animals produced no dilatation of the vessels in the pia.

Schede[2] tested a number of skin irritants, especially the tincture of iodine, as to their local effects on the tissues. He demonstrated that the tincture of iodine, when only painted on the skin, produced the extravasation of migratory cells and œdema not only in the skin, but also in subcutaneous areolar tissue, muscles, and muscular interspaces; but the migratory cells he found also in the periosteum, and even demonstrated inflammatory irritation in the bone marrow and phenomena of granulation in the cells of the epiphyseal cartilages. As we do not know of any such phenomena of inflammation without a previous and accompanying hyperæmia, we can conclude that tincture of iodine applied to the skin renders the tissues to the very bones hyperæmic.

Of late Wechsberg[3] has written on the same subject. On applying with a brush tincture of iodine or other irritants for several consecutive days to the skin of the thigh of a dog, he found an intense hyperæmia and œdema of the skin and the subcutaneous areolar tissue, and in the majority

[1] Schüller, "Über die Einwirkung einiger Arzneimittel auf die Gehirngefässe" (*Berliner Klin. Wochenschrift*, 1874, p. 294).

[2] Schede, "Über die feineren Vorgänge nach Anwendung starker Hautreize, besonders der Jodtinktur" (*Archiv f. Klin. Chir.*, vol. xv., 1873).

[3] Wechsberg, "Über den Einfluss chemischer Gegenreize auf Entzündungen" (*Zeitschr. f. Klin. Med.*, vol. xxxvii., p. 360).

of cases also of the muscles situated below. In this respect mustard-oil had a more decided effect. In all cases, furthermore, there was a decided cellular infiltration of the deeper layers of the cutis and of the subcutaneous areolar tissue, which as a rule extended into the muscles. The strongest effect in this respect is obtained with croton-oil, the weakest with tincture of iodine. In all experiments, with the exception of those made with mustard-oil, we find the remark: "No positively demonstrable anæmia of the deeper parts." In spite of this, Wechsberg, making his deduction from totally unproven theoretic calculations, surprisingly concludes that the skin irritants produce anæmia of the deeper parts.

In my opinion, such experiments as those of Zülzer and Wechsberg offer no proof. I consider it impossible to decide by macroscopic examination of deep parts in section as to their volume of blood, especially in the muscles of rabbits, in which the reaction hyperæmia following artificial bloodlessness can hardly be seen, as I have become convinced by my own experiments. In such things we surgeons have an entirely different experience, which proves more than physiological experiments. I have always found that in deeply situated foci of inflammation the skin incision is more bloody than in a normal body. Thus, I have even expressed my suspicion, when in an exploratory laparotomy the wound of the abdominal wall bled freely, that we should find in the depth of the belly an inflammatory condition, and as a rule I was right. And yet we have here to deal with vascular areas which are related only by means of insignificant adhesions. In accordance with this, I have frequently found the temperature of the skin in deeply situated chronic inflammation (tuberculosis) elevated one or more degrees. Is it possible that an inflammation in the deeper parts affects the surface differently than if the reverse were the case?

Besides this, other experiences testify that the stimulus of inflammation renders neighbouring regions hyperæmic. A deeply situated panaris of the palm causes reddening and œdematous swelling of the back of the hand, and under certain conditions even of the entire forearm. I have of late learned how far a purely chemical inflammation may extend

from the place of application. I injected a pseudo-arthrosis of the thigh—which had resisted all sorts of treatment, including suture of the bones and injection of tincture of iodine with oil of turpentine—and caused it to heal quickly. But an intense reaction developed. The leg became œdematous from the toes to the inguinal fold, became everywhere very hot, and remained in this condition for several days. Recently Haffter[1] has made an interesting observation. He could demonstrate blood in his urine after the application of mustard plaster placed on the region of the loins as a "derivative," a proof of the deep effect of a chemical irritant.

These conditions were experimentally investigated by Samuel,[2] in a contribution which is a masterpiece of macroscopic observation, and in which the author arrives at very similar results. He produced an inflammation of the upper half-ear of a rabbit by scalding with water of 54° C. An inflammatory lesion developed immediately, limited by a sharp line corresponding to the extent of the causative factor. Soon, however, the inflammation spread over the entire ear, even farther over the skin of the head and back. The skin was œdematous, reddened, and hot to the feel. These phenomena reached their maximum after eighteen to twenty-four hours, and then gradually disappeared.

Recently Wessely[3] has ingeniously demonstrated the remote effect of subconjunctival injections of saline solutions used in ophthalmic practice. After injections of a 5 to 10 per cent. solution, he noticed an enormous increase of albumin and fibrin in the aqueous humour of the eye, which as a rule is poor in these substances. It is clear that the albumin could come only from the dilated ciliary vessels, which have become more permeable. Wessely proved this strikingly with rabbits, which had been immunized against ox-blood. Their normal aqueous humour showed no hæmolytic properties for ox-blood, but if saline solution had been previously injected beneath the conjunctiva, the aqueous humour had a decided hæmolytic effect on this blood.

[1] Haffter, "Besprechung der ersten Auflage dieses Buches im Correspondenzblatt für Schweizer Arzte," vol. xxiii., 1903, No. 14, p. 489.

[2] Samuel, "Entzündungsherd u. Entzündungshof" (*Virchow's Archiv*, vol. cxxi., No. 2).

[3] Wessely, "Experimentelles über subkonjunctiv. Injektionen" (*Deutsche Med. Wochenschrift*, 1903, Nos. 7 and 8).

The aqueous humour showed a similar relation in animals immunized against typhus. It contained normal, small quantities of typhus agglutinin, which became greatly increased by subconjunctival saline injections, as shown by Widal's test. These immunizing bodies could only come from the dilated ciliary vessels.

Corresponding to my above-cited observation, we have here a new example of an inflammatory stimulus extending from one vascular territory to another, though the areas have no connection whatever with each other—in this case from the conjunctival to the interior vessels of the eye. Wessely rightly attributes to hyperæmia the repeatedly observed favourable effect of subconjunctival saline injections in all possible diseases of the eye.

In my opinion, the differentiation of various effects of revulsion on deeper and less deeply situated parts can but lead to confusion. For what is deep and what less deep ? If we, for instance, apply tincture of iodine to the skin over a pseudo-arthrosis of the thigh, we can undisputably speak of a deep part, and in accordance with that view we render the bone anæmic ; if we apply the iodine to the skin over a pseudo-arthrosis of the lower end of the radius, we have to deal with a superficial part, and we render the bone hyperæmic. Therefore, in both instances we should produce directly opposite results.

On careful consideration, we can see that whenever we apply these theories we arrive at contradictions. For the derivantia have proved themselves effective in lesions situated below the skin or mucous membrane (and these, in accordance with the unanimous views of the experimenters, must be regarded as superficial structures), but they also are rendered hyperæmic ; therefore they are not concerned in the intended revulsion.

I believe that the effect of revulsion depends principally on hyperæmia, and conclude this first of all from the fact that it has, as a rule, identically the same effect as that observed as resulting from our agents for the production of hyperæmia. Their pain-relieving effect, which has been disputed by no one, is striking ; even the opponents of these remedies have had to admit this, and for explanation resorted to the convenient excuse that this was due to sug-

gestion. We shall, however, later on show that any kind of hyperæmia, active as well as passive, has a pain-relieving effect. Inasmuch as the derivantia are agents producing inflammation, and as inflammation produces a slower blood-current, we shall have to compare their effect with that of passive hyperæmia. And both really have identically the same effect. The derivantia have been used in inflammation and pseudo-arthrosis as resorptive and dissolving agents, and we shall see later on that passive hyperæmia produces the same, and active hyperæmia some of these effects. This superb uniformity in the effects is far more convincing than those uncertain physiological experiments which led to such variable results among the observers.

After I had asserted that the favourable effect of the derivantia—and especially of heat on diseased parts—is not due to the production of anæmia, but hyperæmia, Buchner[1] accounted for in a like manner the good results obtained from the treatment of infectious diseases by means of Salzwedel's alcohol dressing. I have no doubt that alcohol, especially in the form of Salzwedel's dressing, can be classified as a derivans, and this has been customary for some time, equally if the alcohol was applied pure or in the form of a tincture with the addition of some other skin irritant; nevertheless, I do not agree with the experiments cited by Buchner as proof. His experiments are erroneous, because it is quite a different thing to produce hyperæmia by the hypodermic injection of alcohol, and to assert that the drug applied to an uninjured skin produces the same result in the deeper tissues. If this were really so, with the exception of normal saline solution and artificial blood serum, there would scarcely be a liquid remedy which would not produce hyperæmia. They are all irritants which, when injected into the tissues, finally produce inflammatory hyperæmia. It is just as false to conclude, from the increased blood-pressure observed by Buchner and his collaborators, a hyperæmia or an acceleration of the blood-current, for we know from a wide physiological and clinical experience that often extreme local anæmia and diminution

[1] Buchner, "Natürliche Schutzeinrichtungen des Organismus und deren Beeinflussung zum Zweck der Abwehr von Infektionsprocessen" (*Münch. Med. Wochenschrift*, 1899, Nos. 39 and 40).

of the blood-current is associated with increased blood-pressure, while enormous hyperæmia and acceleration of the blood-current is accompanied by a lessened blood-pressure.

An experiment made by Heinz[1] seems to me to offer better proof for the hyperæmic effect in the deeper parts of the alcohol dressing. This experimenter demonstrated by means of thermo-electric needles a temperature increase of 0·15 to 0·25° C. in the pleura after the application of an alcohol dressing to the external skin of an animal.

The application of the actual cautery to the skin is also counted among the derivantia. This, too, is an ancient remedy which occasionally has been forgotten, but again and again restored to its place, and of late again made popular by Rust. Even to-day it is not entirely forgotten as a "derivans," and is used for painful and stubborn inflammation of the vertebræ, in which the skin is cauterized at both sides of the cornua. That this remedy produces an intense hyperæmia of the skin goes without saying; that a hyperæmia is produced also in the depth is probable, for if the burn does not remain aseptic a prolonged inflammatory hyperæmia will be the result. This will be especially the case if suppuration be maintained, as has been the custom, by the introduction of peas or by the application of cantharidin collodium.

Two comparatively new contributions deal with the effect of the cautery on the blood-volume in the deeper vessels. Wolter[2] reports the post-mortem finding in a case of tetanus, in which Busch, two days before death, had burned two strips alongside the vertebral column with the cautery in order to affect the spinal cord of this condition. "On section the muscles of the back were of a dark-brownish colour, soft and flabby, the veins in the vicinity of the spinal column intensely hyperæmic. The space of the spinal canal exterior to the dura was filled with a loose blood-coagulum. It gave the impression of a delicate stratum of connective tissue being strongly infiltrated with thin blood

[1] Heinz, "Die Wirkung äusserer (thermischer u. chemischer) Reize auf d. Blutverteilung in d. Tiefe" (Transactions of the Nineteenth Congress of International Medicine, 1901).

[2] Wolter, "Über das Ferrum candens als sog. Derivans," Inaug. Diss., Bonn, 1873.

mixed with serum. The dura mater was strongly imbued, the pia mater decidedly hyperæmic and somewhat œdematous. The superficial veins appeared serpentine." Wolter then experimented with rabbits, and found that when he cauterized the skin at the sides of the spinal column, not only the muscles below the skin, but also the spinal column, the meninges, and even the cord itself, became hyperæmic.

Schwering[1] confirmed Wolter's experiments. He found from the same experiments hyperæmia which reached the meninges. Among three experiments he found once, after cauterizing a strip 5 centimetres long and 2 centimetres wide over the skin in the region of the stomach, that the abdominal wall and the anterior wall of the stomach were hyperæmic. "At some distance from this hyperæmic place, however, the wall of the stomach was plainly anæmic."

In the other experiments Schwering could not confirm Zülzer's statement concerning the production of anæmia in the deeper parts by the derivantia. Nevertheless, he draws the surprising conclusion, from finding it in the stomach, that the cautery, like all derivantia, "produces in the immediate vicinity hyperæmia and somewhat farther away anæmia."

I have already mentioned above that I place very little value on the post-mortem observations as regards the volume of blood of individual bodily parts. Nevertheless, the former observation is of greater value than the latter, because on cutting into hyperæmic organs the blood flows easily, and, besides, one never knows whether muscles and viscera did not express the blood in the ante-mortem contractions. But, in my opinion, quantities of blood can be found even in places where it was absent before death, and the uncertainty of these experiments is evident from Wolter's statement that he has found hyperæmia extending to the spinal canal even in the healthy control animals. For me, the only proof for hyperæmia in the depth following the application of the cautery to the skin is the post-mortem observation of the patient reported by Wolter. Here, below the burn, in the spinal canal was a turbid blood-coagulum, the dura mater was involved, the pia mater œdematous. The cautery, therefore, had produced on the distant parts

[1] Schwering, "Über das Ferrum candens," Inaug. Diss., Berlin, 1875.

changes which all strong derivantia produce—namely, hæmorrhages and phenomena of inflammation which could be neither post-mortem appearances nor artificial products. I scarcely need to add that I also consider the actual cautery —this most powerful of all derivantia—as an agent producing hyperæmia. A consideration of the moxæ, setons, and fontanelles, which belong to the same class, will be considered below. I only remark, in order not to be misunderstood, that I do not mean to deny reflex action of the derivantia and revulsiva on distant parts, and I admit that there exists a possibility to thus effect cures. It seems to me more probable that these agents produce chemical changes of the blood and of the tissue serum at the place of application, which find their way into the circulation and effect curatively distant bodily parts. In a future chapter I shall return to the probably existing remote effects. However, I believe I have positively proven one of the possible curative effects of the derivantia, namely, that their main effect is the production of hyperæmia in the affected parts. In this respect they do the opposite to what their name indicates. Even the effect of some internal and many external remedies no doubt partly depends on the production of hyperæmia which they induce.

This premise applies, above all, to the so-called adstringentia and similar remedies. For a long time diseases of the conjunctiva have been treated generally with strong solutions of silver nitrate, copper, and zinc sulphate. It is peculiar that these strong remedies should diminish inflammation after an initial increase. Lately Fuchs[1] has expressed the view that the hyperæmia produced by these agents leads to a transudation under the cautery eschar, which, in throwing it off, removes at the same time the bacteria. I believe the healing effect of hyperæmia can be much more simply explained in a different manner, as I will show in the next chapters.

Two excellent examples can be cited from the domain of dermatology and sexual diseases. Hebra causes the disappearance of chronic eczemata by friction with caustic potash, thus producing an intense hyperæmia and acute inflammation.

[1] Fuchs, "Lehrbuch d. Augenheilkunde."

Chronic gonorrhœa is not infrequently cured only after irrigations with silver nitrate, especially when this is undertaken according to Janet's method. Acute gonorrhœa also can frequently be removed in a few days with Janet's irrigations with potassium permanganate. The weak disinfecting effect of these remedies does not induce the cure, which can be proved by the fact that stronger antiseptics produce no effect on gonorrhœa.[1] Here, too, the powerful inflammatory hyperæmia and its sequelæ may produce the cure. For after Janet's irrigation in acute gonorrhœa, a formidable œdema of the penis and increased serous discharge from the urethra can be seen. The widespread conception that the serous flooding of the mucous membrane mechanically removes the gonococci—thus producing a cure—is probably as erroneous as the above-cited similar opinion of Fuchs' of the effects of the caustics used in ophthalmology. We see that a pure hyperæmia in other regions cures a gonococcic metastasis astonishingly, and in this instance a mechanical removal of bacteria is out of the question.

We could quote from the older medical treatises a whole series of other examples, where the intention was to cure a chronic inflammation by the production of an acute one by means of chemical irritants. I take it that we unconsciously make use of the same thing even to-day, and in popular medicine this procedure is very widespread.

It is not unlikely that the effect of some medicaments is partly due to the hyperæmia produced by them. We know that salicylic acid produces a decided hyperæmia of peripheral parts. Thus is explained the reddening of the skin, sweating, tinnitus aurium, and disturbances of vision, observed from its use. A similar effect is obtained from the use of alcohol. Tartarus stibiatus, taken internally, produces, in addition to reddening of the skin and exanthemata, enormous hyperæmia of the mucous membranes. I believe it possible that the favourable influence of salicylic acid in acute articular rheumatism is based on this ability to produce

[1] Gonorrhœa offers an excellent demonstration of the lack of value of antiseptics in established infection, for here we have to deal with a micrococcus in a narrow urethra which we can thoroughly irrigate with our antiseptics, which, bacteriologists tell us, is weak and susceptible to antiseptics; yet we do not succeed in destroying it once it has penetrated the least depth.

hyperæmia, for we shall see later on that the production of artificial hyperæmia of the joints affected with the disease also quickly relieves the pain and swelling. With this theory the fact agrees that salicylic acid as a remedy producing hyperæmia only in peripheral parts has also an effect only on affections of the joints, leaving unaffected inflammation of internal organs, especially inflammation of the pericardium, which it neither prevents nor removes.

I have stated that massage and electricity also produce hyperæmia, in addition to other effects. In explaining the favourable influence of these remedies on disease, hyperæmia must also be considered, naturally. I further consider Priessnitz's compress as an agent producing hyperæmia. I have repeatedly expressed the view that the favourable influence of tapping on tuberculosis of the peritoneum, pleuræ, and meninges, is in all probability due to the hyperæmia produced by the procedure.

In conclusion I must mention Finsen's light treatment of lupus. Apart from other effects, this treatment, according to Forchhammer, a pupil of Finsen, has the following result :[1]

"Immediately after such a treatment the skin appears red and swollen. This reacting gradually increases, reaches in about twenty minutes the maximum, usually with the formation of a blister. If external infection is avoided, the reaction ends after eight to ten days with a superficial exfoliation. There yet remains an intense redness, which disappears totally only after several months. This inflammatory process has undoubtedly a great share in the success, apart from the bactericidal effect."

Finsen[2] himself and his pupil Bie[3] also place great weight on this property of the light, and ascribe to it a part of the successs in the cure of lupus. For we also see that other hyperæmic inflammatory processes—*e.g.*, erysipelas—can cure this disease. I myself[4] saw a considerable retrogression and epitheliazation of the lupus in hopeless cases of lupus

[1] Forchhammer, "Die Finsentherapie u. ihr gegenwärtiger Stand in der Dermatologie," Kopenhagen, 1901, and Seventh Congress of the Deutsche Dermatol. Ges., Breslau, 1901.

[2] Finsen, "Über d. Anwendung von konz. chem. Lichtstrahlen in d. Medizin," Leipsic, F. C. W. Vogel, 1899.

[3] Valdmar Bie, translated by Schramm, "Die Anwendung d. Lichtes in d. Med.," Wiesbaden, J. F. Bergmann, 1905.

[4] Bier, "Die Transfusion von Blut, insbesondere von fremdartigem Blut und ihre Verwendbarkeit zu Heilzwecken" (*Münch. Med. Wochenschrift*, 1901, No. 15).

after transfusion with alien blood, which produced a magnificent hyperæmia in the lupus.

The chemic rays in Finsen's electric arc light and the Röntgen rays can be compared in their effect with congestion hyperæmia, because both considerably increase the inflammation, while chemic rays even produce it. Local incandescent lamp baths, however, must be compared to the hot-air baths, because of the absence of chemical rays, leaving only the effect by heat.

The number of remedies by which hyperæmia is unconsciously produced in the diseased focus is by no means exhausted by the above. It is therefore clear that numerous agents are at our disposal for the production of hyperæmia, and it may appear one-sided to limit myself to only two kinds. On careful consideration, we shall find that this is necessary. For in these remedies we have the two extremes : on one hand the great acceleration of the blood-current by hot air, on the other hand any desired diminution by means of the stasis bandage and the cupping apparatus. We can thus not only study the pure effects of hyperæmia, but also establish accurately when the various kinds of hyperæmia have a like or unlike effect. Besides, I believe that there is not another agent which can produce both extreme forms as intensely, and this, after the limits have been established, without damage to the body. All those remedies which act somewhat similarly to the derivantia do so only indirectly by injuring the tissues, just as is the case in inflammation, and they do not permit of exact dosage, as we can never say in advance how long and how intensely a mustard plaster, for instance, will affect a given individual. Both our agents, on the contrary, if properly applied, do not injure the tissues, and can be measured as regards dose just as definitely as an internal medicine.[1]

[1] This difference was not appreciated by Wolff (discussion on Kuhn's address, *Deutsche Med. Wochenschrift*, 1906. No. 29, p. 1177) when he compared the effect of formalin vapours with that of congestion hyperæmia.

INFLUENCE OF HYPERÆMIA ON THE LYMPH-CURRENT

The answer to the following question seems of great importance: How do the agents producing hyperæmia affect the lymph-current? We will not here discuss the dispute in regard to the origin of the lymph, whether it is a transudate or a product of secretion of the endothelia of the capillaries, as it has no bearing upon our problem.

The old view which considered the lymph to be a transudate of the bloodvessels was based on the obvious fact that the lymph-current of a bodily part is dependent on its blood-pressure and blood-volume. Accordingly, any hyperæmia, active as well as passive, must produce an acceleration of the lymph-current. Doubt was first cast upon this doctrine by a contribution by Paschutin,[1] which was perfected under Ludwig's supervision. He demonstrated that the most pronounced arterial hyperæmia, which he produced on the fore-legs of dogs, remained without any influence whatever on the celerity of the lymph-current. He produced hyperæmia by cutting the plexus brachialis, and verified the appearance of hyperæmia by demonstrating an increase in the temperature of the limb.

Paschutin did not even notice an increase of the lymph-current when, in addition to the cutting of the brachial plexus, he severed the cord in the neck and stimulated it, though the blood-pressure increased four to nine times, and accordingly, in the paralyzed limb with its dilated vessels, the greatest possible arterial hyperæmia must necessarily have taken place. He could not even retard the usual sinking of the lymph-current, which always occurs in prolonged experiments. Among numerous experiments, he could only twice produce a slight acceleration of the lymph-current, but in each instance was able to demonstrate that this was due to an evident error in the experiments.

[1] Paschutin, "Über d. Absonderung d. Lymphe im Arme des Hundes" (Report of the Kgl. Sächs. Ges. d. Wiss., Math. Physic. Class, 1873).

Paschutin's results were confirmed by several others, principally by Emminghaus,[1] who also experimented under Ludwig's supervision, as well as by Jankowsky,[2] who worked with Cohnheim. He, too, found that arterial hyperæmia, produced in a normal extremity by paralysis of the vaso-motors, does not only not accelerate the lymph-current, but, on the contrary, frequently retards it. If, however, he produced an inflamed extremity, or if he rendered the animals artificially hyperæmic, then the vaso-motor paralysis accelerated the lymph-current. On the other hand, other experimenters always found the lymph-current accelerated and increased in arterial hyperæmia. Rogowicz,[3] who worked under Heidenhain, asserted that any arterial hyperæmia, no matter how produced, as long as it is followed by an increase of temperature in the part involved, increases the lymph-secretion and accelerates the lymph-current. Paralysis of the vaso-motors, stimulation of the dilators, and arterial hyperæmia, produced by poisons, all had the same result. Rogowicz ascribes to the following experiment the main proof : He rendered half of the tongue hyperæmic by repeatedly stimulating the lingual nerve, and injected at the same time into the saphenous vein a saturated solution of sodium indigo sulphate. The hyperæmic side became quickly blue, while the other parts at first retained their normal colour, being dyed later. If the one-sided hyperæmia was prolonged until the other half of the tongue also became blue, the hyperæmic side decolorized much more rapidly than the other side. From this Rogowicz concludes that the lymph which carries the colouring matter to the tissues is more rapidly excreted on the hyperæmic side, and that in prolonged hyperæmia an increased lymph-current again washes away more rapidly the colouring matter in the concerned side. He also found that the lymph of an arterially hyperæmic limb, when the conditions in the experiments above described existed, looked more blue than that of the corresponding other extremity.

[1] Emminghaus, "Über die Abhängigkeit d. Lymphabsonderung v. Blutstrom" (Contributions from the Physiol. Institute at Leipsic, 1873).

[2] Jankowsky, "Ueber die Bedeutung der Gefässnerven für die Entstehung des Oedems" (*Virchow's Archiv*, vol. xciii., p. 259).

[3] Rogowicz, "Beiträge zur Kenntnis der Lymphbildung" (*Pflüger's Archiv*, 1885, p. 252).

Pekelharing and Mensonides[1] also saw a considerable increase of the lymph-current in arterial hyperæmia of a hind-leg which they had produced by cutting through the sciatic nerve.

Chabbas,[2] who worked under Grünhagen, was able to demonstrate that "the secretion of the aqueous humour is a direct function of the blood-pressure." He showed that the lowering of the blood-pressure by narcosis with chloral hydrate diminished, while increase of the pressure by nicotin or ligation of the aorta above the diaphragm increased, the secretion of the aqueous humour.

These observations have been confirmed by others with still more exact experiments, and in a more recent contribution Leber[3] has recognized their correctness. If the experiments concerning the dependence of the lymph-secretion on blood-pressure and fulness of the vessels are to be decisive, first of all the certain proof must be established that aqueous humour and lymph are one and the same. Many investigators, it seems to me, use the term "lymph" to cover a broad conception. Thus, Emminghaus[4] counts œdema, hydrops, anasarca, hydrothorax, ascites, as included under it, and asserts that "œdema and increased lymph-secretion are identical." If we, furthermore, consider the unnatural conditions under which these experimenters worked—animals poisoned with nicotin and curare, whose spinal cords and nerves were cut, whose aortas ligated, and artificial respiration induced—we shall doubt the strength of the proof offered by these experiments, and understand the entirely opposed results. The conclusion we must, therefore, draw is that we do not know whether and how the arterial hyperæmia affects the lymph-current.

Just as these views differ, so is there a pleasing unanimity in those held in regard to the influence of induced hyperæmia on the lymph-current. All observers, without exception,

[1] Pekelharing and Mensonides, cited after Virchow-Hirsch's *Jahresberichte*, 1887. The original was inaccessible.

[2] Chabbas, "Ueber die Sekretion des Humor aqueus in Bezug auf die Ursachen der Lymphbildung" (*Pflüger's Archiv*, vol. xvi., 1878, p. 143).

[3] Leber, "Merkel-Bonnets Ergebnisse der Anatomie und Entwicklungsgeschichte," 1894, p. 156.

[4] Emminghaus, "Physiologisches und Pathologisches über die Absonderung der Lymphe" (*Wunderlich-Roser's Archiv der Heilkunde*, vol. xv., 1874, p. 369).

found the excretion and the current of lymph greatly increased by it.

The first experiments on this subject were made by Tomsa.[1] He found that when he checked the venous blood-stream in the spermatic cord, while the arterial flow remained unchanged, the current in the related lymph-vessels became considerably increased.

Emminghaus[2] made the same discovery on the legs of animals as did Gonitschewsky,[3] a pupil of Cohnheim. He produced the congestion hyperæmia with plaster-of-Paris pulp, which he injected into the veins of limbs rendered artificially bloodless, permitting it to dry therein. As soon as this was attained, he released the blood-current, and a decided congestion hyperæmia resulted. This was followed by a decided dilatation of the lymph-vessels and increased lymph-current. The intercepted lymph was liquid and thin, contained many red and few white corpuscles, and was but slightly coagulable.

Pugliese[4] made similar observations when he produced congestion hyperæmia in the fore-leg of an animal by compressing the subclavian vein. But he found in the majority of cases no change in the colour and the solid constituents of the lymph. This difference from the results of the previous observer is explained by the fact that the former produced with plaster-of-Paris pulp an enormous congestion hyperæmia, while Pugliese with the compression of the subclavian vein obtained but a moderate one.

At an earlier date Lassar[5] proved that inflammation also considerably increases the lymph-current. He therefore came to the conclusion that both congestion hyperæmia and inflammation considerably increase the lymph-current. The kinds of lymph show vast differences: the lymph due to inflammation is a yellowish, tenacious, easily coagulating liquid containing many white but few red blood-corpuscles, and on drying leaves a residue which exceeds considerably

[1] Tomsa, "Wiener Sitzungsbericht," vol. xlvi., part ii. Cited after Paschutin. The original was not accessible.

[2] Emminghaus, *loc cit.*

[3] Gonitschewsky, "Ueber Stauungsödem" (*Virchow's Archiv*, vol. lxxvii., p. 65).

[4] Pugliese, "Beitrag zur Lehre von der Lymphbildung" (*Pflüger's Archiv*, 1898, vol. lxxii., p. 603).

[5] Lassar, "Ueber Oedem und Lymphstrom bei der Entzündung" (*Virchow's Archiv*, vol. lxix., p. 516).

that of normal lymph, and many times more than that due to congestion hyperæmia lymph. Lymph due to congestion hyperæmia, on the other hand, is a thin liquid, slightly reddish, imperfectly coagulating, and containing many red and white blood-corpuscles. When Lassar added to the inflammation an arterial hyperæmia by cutting the sciatic nerve, this had no influence on the lymph-current.

All these investigators produced the congestion hyperæmia by ligating or compressing the larger vein trunks, by injection of plaster-of-Paris pulp, or imperfect constriction of the concerned extremity, as we do it in our congestion hyperæmia. But even in the last instance they intercepted the lymph from a vessel below the constricting band. The outflow of lymph was therefore not prevented in any of their experiments. Matters are different with our congestion hyperæmia produced with bandage or cupping apparatus. We constrict the lymph-vessels, too, and as these have still more delicate walls than the veins, we, in all probability, produce a more perfect lymph rather than blood-stasis.

Those experiments, the correctness of which cannot be doubted considering the equal results, can be taken into account by us only in so far as we must allow that after removal of the congestion hyperæmia bandage—that is to say, in the intervals—the lymph-current is increased.

I have already mentioned that we have a kind of stasis formerly designated "white stasis," in which the lymph appeared to me to be retained. At the same time the hyperæmia diminishes, but, nevertheless, the extremities swell and become œdematous. When the hyperæmia is absent the skin looks white. One very rarely sees this form of stasis hyperæmia. I have observed it in tuberculous joints, and do not value it, as it proved entirely ineffective.

GENERAL EFFECTS OF HYPERÆMIA

ANODYNE EFFECTS OF HYPERÆMIA

There is hardly any effect of hyperæmia which is more striking than that of the relief of pain. Both active and passive hyperæmia have this property. We have observed almost constantly that a joint attacked by painful chronic rheumatism becomes less sensitive, and occasionally insensible, after treatment for one hour in the hot-air apparatus. The influence of hyperæmia on the very acute pains in grave forms of gonorrhœal arthritis is much more pronounced. The pains grow less in half an hour to one hour after application of the rubber bandage. I shall describe in the course of this work the astonishing and decided results with regard to the relief of pain in these cases. But in all other painful diseases in which hyperæmia can be employed with success, relief of pain is always its most prominent feature. The various forms of hyperæmia remove neuralgias and headache, and diminish to a considerable extent the sensitiveness of joints which have become painful from various causes.

Earlier, when my experiments with treatment by hyperæmia were applied to a limited number of diseases, I was inclined to consider this peculiar relief of pain as mediate; because the cause of the disease was influenced by the hyperæmia, and with the removal of the cause the symptoms—including the pain—also disappeared. I am still of the opinion that this may play a rôle in the removal of the pain. We can imagine that the active hyperæmia washes away poisonous substances, which produce

pain by injuring the nerve-endings, while the passive hyperæmia dilutes them. Something similar may be the case in injured joints, in which hyperæmia relieves pain. However, the ability to lessen sensibility must be looked upon as a general property of hyperæmia proper. This conclusion will be reached when we remember that the relief in some cases comes on so rapidly—in less than an hour—that there can be no question of a serious influence of the remedy on the cause of the disease.

For an explanation of the anodyne effect of hyperæmia, I refer to the writings of Ritter.[1] He proved experimentally that any form of hyperæmia lessens the sensitiveness to pain. He thinks that the serous infiltration of the tissues diminishes the sensitiveness of the nerves, in a like manner as was demonstrated by Schleich, in his well-known experiments, to be the action of all possible agents which produce œdema.

Bum[2] explains the diminution of pain in diseased joints by congestion hyperæmia in a different manner. He shows that it produces an increase of the contents of the joint, and in that way the surface contact of the affected joint-ends is lessened. It therefore must reduce the pain in a similar way as is accomplished by extension. In my opinion this explanation is nullified by the fact that hyperæmia also diminishes pain in numerous affections of soft parts, where such relations are out of the question.

Active and passive hyperæmia alike relieve the pains met with in a series of diseases—*e.g.*, in all chronic, painful, stiff joints, be these due to chronic rheumatism, arthritis deformans, injuries, or other causes. In all acute painful infectious diseases—*e.g.*, arthritis due to gonorrhœa, acute rheumatism, tuberculosis—passive hyperæmia excels also in its pain-relieving effect, while it seems to me neuralgias are more effectually treated by active hyperæmia. At any rate, we must completely abandon the old view that hyperæmia—*e.g.*, the inflammatory hyperæmia—as such, produces

[1] Ritter, "Die natürlichen schmerzlindernden Mittel des Organismus" (*Verh. d. deutschen Ges. f. Chirurgie*, 31. Congress, 1902; and *Archiv f. klinische Chirurgie*, vol. lxviii., p. 429); and "Die praktische Bedeutung der natürlichen Schmerzlinderung" (*Die Heilkunde*, vol. vii., brochure 5, 1903).

[2] Bum, "Die Behandlung von Gelenkerkrankungen mittels Stauung" (*Wiener Med. Presse*, 1905, Nos. 3 and 4).

pain; for, on the contrary, this pain is due to the injury to the cells and nerve-endings which is found in every inflammation, and the subsequent hyperæmia with its changes, far from producing or increasing pain, decidedly diminishes it. The well-known "thermic" diminution of pain is, in my opinion, produced purely by hyperæmia, and it is a crude error to believe that the heat freed the painful parts from blood by revulsion, or, as it was usually termed, by "decongestion."

The same thing holds good with other hyperæmizing agents. I have already said that the chemical derivantia, in use for ages, have the effect of relieving pain. The dry cupping-glasses have maintained their reputation for relieving pain to this day, especially in dry pleurisy and lumbago. Of course, they too were thought to produce their beneficent effect by rendering anæmic the painful parts previously filled with blood. Unverricht[1] even thought he was able to demonstrate an anæmia of the pleura of bodies dead from pleurisy, which had been treated during life with cupping-glasses. He says:

"Another possible means of relieving pain consists in the employment of *derivative* procedures, which primarily aim at diminishing the hyperæmia of the inflamed pleura. If we succeed in removing the congestion, it invariably follows that pain is also relieved. In this respect very much can be obtained from cupping. I have convinced myself that the spot in the pleura over which the cupping-glasses had been applied can be demonstrated even on the cadaver by a diminution of volume of the bloodvessels. Apparently the blood-stream is deviated outwardly by the suction force of the cupping-glasses."

This fact was published in a treatise in the year 1905, so one sees how difficult it is to remove old, rooted prejudices. I have been vainly fighting for years against the view that hyperæmia produces pain.

I repeat, in reply to Unverricht, what I have already said in the chapter on "Derivantia," namely, that from the distribution of the blood in a cadaver no conclusion can be drawn for that of the living.

My discovery of the anodyne effect of passive hyperæmia stands in direct opposition to the views entertained heretofore, for it was considered self-evident, proved by daily experience, that blood-stasis produced pain. I know that my

[1] Unverricht, "Krankheiten des Brustfells und des Mittelfells," in "Handbuch d. Prakt. Med.," by Ebstein and Schwalbe, vol. i., p. 405.

attempts to cure the pain in inflamed limbs with congestion hyperæmia were received with dubiety. I should not think of wasting time by producing proofs, for if there is anything easy to demonstrate in medicine it is this, and everyone who seriously wishes to be convinced can do so at any time without special art and trouble. All I ask is, that when these experiments are made, they should be done properly, and the bandage should not be so firmly applied that grave disturbance in the nutrition of the tissues develops and the pressure on the nerves causes violent pain. I can only reply, to those who have reported that the congestion hyperæmia produces pain, that they do not know how to execute the technique.

Besides, numerous observations should have convinced us long ago that hyperæmia, including the inflammatory kind and its sequences, relieves pain. For, to name but two examples, the painful maxillary periostitis in dental caries ceases to cause pain when the jaw is swollen, and a fracture of bone when the limb becomes swollen.

In spite of this, however, one clung to the traditional view that hyperæmia produces pain. A logical consequence of this view was that the elevated posture has been generally employed in surgery for the pain of inflammation, and no one has dared to dispute this conviction, that it represented the best and most natural remedy for the inflammation pain. Experience and results seem to confirm this view strikingly. For everyone knows that in the inflamed part the pain becomes violent, pulsating if the part is allowed to hang down, and that the pain ceases or improves when the inflamed extremity is elevated.

And yet this view is fundamentally false. Undoubtedly the pulsating pain ceases soon after elevation, but after this other violently painful sensations manifest themselves. I have often heard patients, whose arms had been elevated for phlegmon of the tendon sheaths, complain of intense pain and inconvenience, and beg for a change of posture of their extremities. They heard in reply: "The elevated posture must be kept up; otherwise you will have still more pain." I can be brief in this respect, for I have proved in numberless cases that the violent pains of phlegmons are diminished by a pronounced congestion hyperæmia—a fact which of late has been confirmed by many, though it must

be admitted that the congestion hyperæmia frequently increases the pulsating pain in the inflammatory area in the first moment.

The anodyne effect of hyperæmia is not only useful in so far as this is agreeable to the patient, but also because soon after its application it restores mobility to the stiffened joints. The stiffness in the joints in all inflammations is caused partially by gross anatomical disturbances, and partially produced and maintained by contraction of the muscles, which contractions are due to painful irritation of the nerves of the joint. With the disappearance of the irritation the contractions, too, cease. Only in this way can it be explained how, after the application of a procedure producing hyperæmia, stiffened joints become so rapidly mobile. Certainly, soon after the discontinuance of the remedy, pain and stiffness return, and it would be only an apparent success if the hyperæmia achieved nothing but the diminution of pain during, or for some time after, its employment. Fortunately, this remedy has also numerous properties, which favourably influence the cause of the disease and its anatomical sequences, so that the pain very soon diminishes or disappears, not only because of the hyperæmia proper, but also on account of the improvement of the disease itself. Of this we shall soon have more to say. Nevertheless, we must ascribe an important rôle to the purely anodyne effect of the hyperæmia. It prevents the limbs from becoming fixed in faulty positions, to which reflex contraction of the muscles leads, enabling us to undertake passive motions at an early period, and to prevent otherwise unavoidable anatomical ankylosis.

BACTERICIDAL EFFECT OF HYPERÆMIA

If we study cases of infectious diseases, such as we shall soon describe, which not only rapidly improve and heal under treatment with congestion hyperæmia, but immediately after the application of the remedy experience a sudden change, we can hardly doubt that we have to deal with a destruction, or at least attenuation, of the causative bacteria. The experimental proof that hyperæmia has this property

has lately been established by Nötzel.[1] He succeeded in keeping alive fifty-one out of sixty-seven rabbits, certain bodily parts of which, while under the influence of a vigorous congestion hyperæmia, were inoculated with otherwise fatal doses of anthrax bacilli and very virulent streptococci. Only sixteen animals died. Without exception, these were animals in which the œdema "from the very beginning had the character of a disturbance of nutrition." In those fatal cases that kind of congestion hyperæmia had been used which I have designated as "cold hyperæmia," to the inefficiency and harmfulness of which I have repeatedly called attention. That it was indeed the congestion hyperæmia alone which saved the animals from death can be concluded from the fact that these same animals were inoculated a few weeks later with the same bacteria without the use of congestion hyperæmia, and that they all died, as did the animals used for purpose of control.

Of course, the fresh artificial infection is something entirely different from that of an infectious disease developed in a natural way, in which the bacteria have adapted themselves to the conditions of the body, and to a certain extent also to its means of defence. Nevertheless, Nötzel's experiments are of great value, as they undoubtedly show that congestion hyperæmia, as such, has bactericidal properties.

Nötzel's experiments have recently been imitated by v. Baumgarten[2] and Heyde, on the congested leg of a rabbit. As regards anthrax, they arrive at the same results as Nötzel. The experiments with staphylococci, however, had a less favourable result. Though limited suppuration of skin and joints healed more rapidly under congestion hyperæmia than without it, extensive abscesses, on the other hand, were rendered rather worse; in experimentally produced tuberculosis of the joints of rabbits the remedy proved practically valueless.

In spite of the negative results in staphylococcus and tubercle bacilli infection, the favourable results obtained by v. Baumgarten in anthrax infection, confirming Nötzel's

[1] Nötzel, "Über d. baktericide Wirkung d. Stauungshyperämie nach Bier" (*Archiv f. klin. Chir.*, vol. lx., No. 1; and Transactions of the Deutsche Ges. f. Chir., Twenty-eighth Congress, 1899, vol. ii., p. 661).

[2] v. Baumgarten, "Experimente über d. Wert d. Bier'schen Stauung auf infektiöse Prozesse" (*Münch. Med. Wochenschrift*, 1906, No. 48).

experiments, are of great importance for my teaching; for they show that an infection, which under all circumstances kills the animal, can be completely overcome by congestion hyperæmia.

v. Baumgarten's experiments on staphylococcus and tuberculosis infection do not correspond with the clinical results which I, and many others, have obtained in man. It is possible that, as in many other experiments, this depends upon the fact that men and rabbits differ essentially, and that an artificial inoculation means something other than a natural infection. I cannot, however, overlook the objection, which has already been made against v. Baumgarten's experiments by v. Brunn,[1] namely, that it is extremely difficult to produce in the leg of a rabbit the right degree of congestion hyperæmia demanded by me; for in man we depend on his own statements in order to apply correctly the right amount of congestion hyperæmia. I have had the same experience as v. Brunn. I have repeatedly asked young colleagues to apply congestion hyperæmia to the leg of a rabbit for the treatment of experimental infection. They never got so far as the infection experiments, for I had to tell them that what they showed me as a correctly congested rabbit leg is something entirely different from what I understand as an effective congestion hyperæmia against infection, and that their experiments were useless.

Joseph[2] called attention to the bactericidal strength of the congestion hyperæmia œdema, and Colley[3] believes he has proved it in the following manner: He inoculated mice with pus from an empyema of an elbow-joint, containing staphylococci. All became ill; the majority perished with the phenomena of sepsis. He then prepared a culture of the pus in bouillon. Half of it he preserved undiluted; to the other half he added three times the quantity of œdema serum, which he had obtained from the congested inflamed extremity. After twenty-four hours he infected mice with the undiluted bouillon, and they usually perished; but inoculation with the

[1] *Münch. Med. Wochenschrift*, 1906, No. 48, p. 2370.

[2] Joseph, "Einige Wirkungen d. natürl. Ödems u. d. künstl. Ödemisierung" (*Münch. Med. Wochenschrift*, 1905, No. 40).

[3] Colley, "Beobachtungen u. Betrachtungen über die Beh. akut eitriger Prozesse mit Bier'scher Stauungshyperämie" (*Münch. Med. Wochenschrift*, 1906, No. 6).

pus to which œdema serum had been added made the mice ill, but did not kill one. The œdema serum obtained from the congested healthy arm of the same man had a very slight influence, or none whatever, on the virulence of the pus. Colley repeated this experiment in diverse forms of suppuration with the same result. He concludes that the œdema liquid of an inflamed bodily part has greater bactericidal properties than that from a non-inflamed part.

Laqueur[1] examined the bactericidal strength of the serum obtained from congested blood in test-tube experiments. He took capillary blood from the fingers of healthy individuals, and also from those affected with chronic rheumatism, and compared two tests in regard to their bactericidal strength, one of which was taken before, and the other after, the application of the hyperæmia bandage. The experiments showed that the bactericidal strength of serum from congested blood was plainly, though not considerably, increased.

Against these experiments, too, the objection can be raised that observations in test-tubes prove nothing for the living body, and that the blood obtained from healthy, and especially chronically rheumatic, individuals differs from the blood which circulates in an acute inflammatory area, since in the latter a more energetic hot congestion hyperæmia can be produced.

v. Baumgarten, however, disputes in his above-cited contribution the results of these experiments. For Heyde ascertained through exact investigations that the bactericidal strength of the congestion transudate is decidedly less than the blood-serum of the same animal.

Wessely[2] made some interesting experiments in this direction. He demonstrated that after warm applications to the eye of rabbits the vitreous humour, which is normally poor in albumin, shows an increase in it. As it can come only from the blood, Wessely correctly assumes that the hyperæmia produced by the warmth is the cause of the increase of the albumin.

[1] Laqueur, "Über d. Einfluss d. Bier'schen Stauung auf die baktericide Kraft des Blutes" (*Zeitschr. f. Experim. Pathol. u. Therapie*, 1905, vol. i.).

[2] Wessely, "Zur Kenntnis d. Wirkung lokaler Reize u. lokaler Wärmeapplikation (nach Experim. am Auge)" (*Archiv f. Klin. Chir.*, vol. lxxi., No. 2)

Inasmuch as the antibodies of the blood, in accordance with their colloidal nature, exude from the vessels in the same measure as other albuminous bodies, Wessely conjectured that in animals artificially immunized the antibodies could be accumulated in increased quantity at certain places by hyperæmizing agents. These conjectures were confirmed by experiments. He found that antibodies produced by immunization of the animals—he selected hæmolysin and typhus agglutinin because of the simplicity of proof—normally pass into the vitreous humour in very small quantities. On the application of local stimuli, especially warmth, the quantities become considerably increased This can be easily quantitatively demonstrated by hæmolysis and Widal's test.

Wessely therefore suggests combining hyperæmia in suitable cases with serotherapy, in order to add a larger quantity of immunizing bodies to the diseased part.

Some time ago Wessely[1] has shown that other local stimuli exercised the same influence. If he injected a 5 to 10 per cent. salt solution under the conjunctiva of rabbits, or if he brushed the conjunctiva with a fine hair brush, the albumin in the vitreous humour became increased, and in animals which had been immunized with alien blood or typhus there was also an increase of hæmolysin and typhus agglutinin. Of much greater weight than all these animal and test-tube experiments, however, are certain absolutely convincing observations, which I have made on diseased human beings. I could repeatedly demonstrate by aspiration that large, hot abscesses, which contained large quantities of staphylococci, and from which a pure culture of staphylococci could be made, became sterile in a short while with the use of congestion hyperæmia alone, without any other surgical procedure, and completely disappeared after they had meanwhile become changed to clear serum.

Naturally an effort has been made to bring this bactericidal effect into harmony with, and to explain by it, the then prevailing theories of the protective powers of the single components of blood.

[1] Wessely, "Experimentelles über subkonjunktivale Injektionen" (*Deutsche Med. Wochenschrift*, 1903, Nos. 7 and 8).

Thus, Buchner[1] holds that in congestion hyperæmia we have not only to deal with a blood-stasis, but with an increased accumulation of leucocytes at the seat of infection, which kill the bacteria by sending alexins into the serum. In contributions[2] of a later date he states that the digestion and dissolution of the bacteria, like all other organic substances in the body, take place through enzymes contained in the blood, and especially in its decomposed leucocytes.

Heller[3] thinks that the congestion hyperæmia retains the products of metabolism of the bacteria, and that these kill their producers. In the cure of tuberculosis we, therefore, have a sort of tuberculin effect.

Cornet[4] explains the curative effect of congestion hyperæmia in a similar manner to Heller. He also sees that the retention of the products of metabolism of the tubercle bacilli is essential, but does not recognize the healing process as due to their annihilating effect on their producers, and believes that they stimulate the tissues to the formation of connective tissue and scars, which encapsulate the infectious focus, making it harmless.

Richter[5] believes that "the successes of the method (congestion hyperæmia) are due to the circulatory disturbance followed by margination and emigration of the leucocytes." He can see nothing else in congestion hyperæmia save the production of the mildest form of inflammation, and places it alongside other methods of treatment which act similarly (tuberculin, cinnamonic acid, chloride of zinc, iodoform).

Nötzel[6] shares Buchner's view that the curative effect of congestion hyperæmia takes place through a concentration of the bactericidal power of the blood at the seat of infection, especially since he has noticed on microscopical examination

[1] Buchner, "Ueber die natürlichen Hilfskräfte des Organismus gegenüber den Krankheitserregern" (*Münch. Med. Wochenschrift*, 1894, No. 30).

[2] Buchner, "Natürliche Schutzvorrichtungen des Organismus und deren Beeinflussung zum Zweck der Abwehr von Infektionsprozessen" (*Münch. Med. Wochenschrift*, 1899, Nos. 39 and 40), and "Zur Lehre von der natürlichen Immunität" (*Münch. Med. Wochenschrift*, 1899, No. 43).

[3] Discussion in Kieler Phys. Verein (in Kiel).

[4] Cornet, "Die Tukerkulose," in Nothnagel's "Specielle Pathologie und Therapie," Vienna, 1899, pp. 545 and 546.

[5] Richter, "Ueber neuere Behandlungsmethoden der Tuberkulose" (*Schmidt's Jahrbücher*, 1893, vol. ccxxxix., p. 180).

[6] Nötzel, *loc. cit.*

that there is a large quantity of leucocytes in the serum. He therefore believes that its protective effect is superior to that of normal blood-serum.

Hamburger[1] has explained the curative effect of congestion hyperæmia in a different way. The hyperæmia makes the blood richer in carbonic acid, and this increases the bactericidal property of the serum—first, because the carbonic acid itself kills bacteria; second, because under its influence the red blood-corpuscles swell, dehydrating the serum and increasing its concentration; and, finally, because the serum gains in diffusible alkali. The latter occurs partially because with the greater concentration of the serum the percentage of alkali becomes greater, partially because under the influence of the carbonic acid alkali passes from the blood-corpuscles into the serum, liberating diffusible alkali through decomposition of the albuminates of the serum.

Numerous bacteriological examinations (for the literature see originals) prove the influence of the alkalis on the antibacterial effect of the blood. Thus, for example, according to v. Behring, the susceptibility of rats to anthrax depends on the alkalinity of the blood. v. Fôdor could increase the resistance to anthrax by the injection of alkali into the blood, and diminish it by the injection of lactic acid. Furthermore, in immunized animals increased alkalinity of the blood is present.

In order to substantiate the correctness of his views, Hamburger cites a series of observations by physicians, such as the rarity of tuberculosis among lime-workers, who inhale, during a great portion of their lives, air rich in carbonic acid, and the frequency of this disease among proletarians, who nourish themselves principally with potatoes. The latter observation is to be explained by the fact that vegetable food diminishes the alkalinity of the blood, while animal food increases it. Hamburger could furthermore demonstrate that the bactericidal property of blood is increased in venous congestion, and on this he lays special stress—that the developed lymph œdema is a stronger

[1] Hamburger, "Ueber den Einfluss von Kohlensäure bezw. von Alkali auf das antibakterielle Vermögen von Blut- und Gewebsflüssigkeit, mit besonderer Berücksichtigung von venöser Stauung und Entzündung" (*Virchow's Archiv*, vol. clvi., brochure 2, p. 329, 1899).

bactericide than the corresponding blood-serum, which otherwise excels normal lymph. As the bacteria are usually situated in the lymph-spaces, this finding is especially important, and explains the favourable effect of congestion hyperæmia. The bactericidal property of exudates is increased by carbonic acid in proportion to the increased amount of leucocytes contained in the liquid.

In a second contribution Hamburger[1] examined the influence of venous congestion on phagocytosis. He reaches the conclusion that its influence on chemotaxis is small, and only large quantities of carbonic acid diminish the motility of the leucocytes to such an extent that they lose the property of taking up carbon particles.

Hamburger is careful enough to look upon the bactericidal properties of carbonic acid as one of the salutary influences of congestion hyperæmia, and does not assert that it is the only effective part of the remedy. Inasmuch as it is well known from older contributions, confirmed by the above-named investigators, that in a moderate hyperæmia—in a pronounced one the emigration of leucocytes ceases—leucocytes emigrate in large numbers to the diseased place, the favourable effect of this remedy could be conjectured also, as in Metschnikoff's phagocytosis. v. Leyden and Lazarus[2] found that the leucocytosis is considerable in therapeutically applied congestion hyperæmia. The number of leucocytes in the congested part multiplied two to three times.

v. Baumgarten[3] thinks that the venous congestion damages the tissue involved; but that it is in so far useful as it also becomes antagonistic to the bacteria—and that to a greater extent than to the tissue cells—owing to the pathologic change in the tissue metabolism produced by the hyperæmia. The bacteria, therefore, under congestion hyperæmia die from hunger, so to speak. This conception is very near, and has been repeatedly expressed to me in conversation by one of my highly esteemed teachers, who liked to express himself drastically and strikingly, thus:

[1] Hamburger, "Ueber den Einfluss von venöser Stauung und Kohlensäure auf die Phagocytose" (*Virchow's Archiv*, vol. clvi., brochure 2, p. 375).

[2] v. Leyden and Lazarus, "Ueber d. Beh. d. Gelenkentzündungen mit d. Bier'schen Stauungshyperämie" (*v. Leuthold-Gedenkschrift*, vol. i.).

[3] v. Baumgarten, "Experimente über die Wirkung d. Bier'schen Stauung auf infektiöse Prozesse" (*Münch. Med. Wochenschrift*, 1906, No. 48).

"Why do you exert yourself to explain the effect of congestion hyperæmia? The thing is very simple; you permit the bacteria to starve, choke, and drown, in the venous blood." But the thing is by no means so simple. In the chapter on the nutritive effect of hyperæmia I shall explain that the useful degree of hyperæmia for infections by staphylo- and streptococci must not represent a disturbance of nutrition, and that any pronounced restriction of nutrition constitutes a grave danger. This does not mean that for certain infections—*e.g.*, anthrax—Baumgarten's conception is incorrect.

My assistants Joseph[1] and Hofmann[2] have rightly pointed to the usefulness of the irrigation of open infected wounds by the profuse œdema liquid, produced by congestion bandage and cupping-glass. Lexer[3] goes so far as to consider the main usefulness of congestion hyperæmia therapy to be this mechanical flooding of the pus focus. This is a very one-sided conception. How can the cure of these cases, which I have partly described in this book, be explained in this manner? I repeatedly aspirated joints with grave suppuration and other abscesses, and demonstrated pus and staphylococci. I subjected the affected extremities to congestion hyperæmia for some time. All phenomena disappeared. I aspirated again, and removed sterile serum. In these cases no external wounds were present, yet the abscesses disappeared.

It is evident from what has been said that the congestion hyperæmia, considered theoretically according to modern conceptions and theories, is a justifiable and logical remedy for diseases which are produced by bacteria; for it is not opposed to any of these theories, but is, on the contrary, in accord with all of them.

I am far from underestimating the value of those bacteriological investigations, but cannot refrain from pointing out that they all suffer from a certain one-sidedness. Let

[1] Joseph, "Einige Wirkungen des natürlichen Ödems und der künstl. Ödemisierung" (*Münch. Med. Wochenschrift*, 1905, No. 40).

[2] Hofmann, "Veränderungen im Granulationsgewebe fistulöser fungöser Herde durch Hyperämisierung mittelst Saugapparate" (*Münch. Med. Wochenschrift*, 1905, No. 39).

[3] Lexer, "Zur Beh. akuter Entzündungen mittelst Stauungshyperämie" (*Münch. Med. Wochenschrift*, 1906, No. 4; and Transactions of the Deutsche Ges. f. Chir., 1906, i. 238).

us rather take this standpoint, and look upon inflammation as something salutary, seeing Nature does nothing uselessly, and that all the numerous changes which develop alongside and after each other are for the purpose of suppressing or fighting infection. We shall then admit that, among the many changes, the above-mentioned alteration in the components of the blood, recognized by exact experiments, has a wholesome effect; but in addition we shall have to point out that, besides this, a number of processes take place which may also be useful, but of which at present we have no exact knowledge, therefore much less of their effects. The only thing which in warm-blooded animals is common to all inflammations, without exception, from the simplest to the gravest, and which ranks above all other phenomena, is the change in circulation which always leads to hyperæmia, and which so far no one has satisfactorily explained. We shall therefore have to recognize this process from which all other phenomena afterwards develop as the most significant and most important. For it is not absent when parts free from vessels are irritated to inflammation, and it is by means of the hyperæmia of the surrounding vascular parts that the body reacts to the inflammatory irritation. It even happens that a quickly disappearing hyperæmia remains as the only reactionary process of the injury from the inflammatory irritation, and that further changes from this hyperæmia do not even appear. Here we must conclude that the hyperæmia in itself was sufficient to remove the injury.

For this reason we do but imitate a natural healing process, when we increase the already existing hyperæmia in certain bacterial affections, and institute it especially there where it is not sufficient. For it is theoretically conceivable that Nature frequently does not accomplish enough in such cases. We can, for instance, assume that a man whose body does not react by a sufficient hyperæmia to a tuberculous infection, from which hyperæmia the other inflammatory healing phenomena successively develop, is attacked by tuberculosis for this very reason, or that the latter is unable to heal after it has developed. We can easily imagine that certain bacterial diseases are stubborn and chronic for the reason that their hosts do not yield the necessary inflam-

matory irritation which again liberates the healing forces of the body, and that we can effectively support Nature by artificial aid in such cases. For I have repeatedly asserted that the forces of the body are frequently imperfect, though one must be blind not to recognize their purposiveness.

A disease to which the body does not react with the necessary inflammatory hyperæmia and its subsequent phenomena, it seems to me, is chronic articular rheumatism (apart from the acute inflammatory exacerbations which occur in this affection). Men attacked by it frequently have a sensation of cold in the affected limbs. I could demonstrate in some cases which I examined, a lower temperature of the skin over the affected extremities than is usual in tuberculous chronic inflammations. And yet chronic articular rheumatism, as I shall hereafter discuss, is favourably influenced by all forms of hyperæmia, though not always cured. Accordingly, we have here a disease where the natural aids of Nature regularly fail, so that they have to be artificially replaced.

As my early investigations with the ordinary clinical thermometer were made in but few cases, I declared further exact investigations on this subject desirable. These investigations have meanwhile been instituted by several investigators, and my observations have been confirmed. Herz[1] found a diminution of cutaneous temperature over chronically diseased joints, irrespective of whether this was due to chronic rheumatism, injuries, or gonorrhœa. Sommer[2] came to the same conclusion. Both availed themselves of the differential air-thermometer designed by Herz.[3]

As this instrument did not prove reliable enough to us in our examinations, and as Meissner[4] described its deficiencies, I caused Kothe[5] to undertake the measurement with more delicate instruments. He chose the thermo-electric pro-

[1] Herz, "Ueber d. Temperaturverhältnisse chronisch erkrankter Gelenke u. gestauter Gliedmassen" (*Berliner Klin. Wochenschrift*, 1903, No. 20).

[2] Sommer, "Über die mittelbare und Dauerwirkung der Licht- u. Wärmestrahlung auf d. Hauttemperatur" (*Berliner Klin. Wochenschrift*, 1903, No. 40).

[3] Herz, "Eine neue Methode der Thermopalpation" (*Wiener Med. Presse*, 1897, No. 7); and Herz and Hiebel, "Über Thermopalpation" (*Wiener Med. Presse*, 1897, Nos. 7 and 8).

[4] Meissner, *Berliner Klin. Wochenschrift*, 1903, No. 50.

[5] Kothe, "Studien über die Temperatur erkrankter und hyperämisierter Gelenke" (*Münch. Med. Wochenschrift*, 1904, No. 31).

cedure as the best, and selected Paschen's very sensitive galvanoscope, which he modified for his purposes. Kothe now found the cutaneous temperature increased over all acutely inflamed joints, in suppuration by 5° C. and more, in acute articular rheumatism by 1° to 2°. Acutely inflamed joints due to trauma showed throughout greatly increased cutaneous temperature, which occasionally persisted for weeks. Kothe found, in accord with my earlier investigations, without exception in chronic tuberculous arthritis, an increase of temperature, which was frequently considerable. On the other hand, the skin over joints affected with chronic rheumatism was invariably lower by 1° to 2° C.; never was there an increase, and rarely the same temperature, as that of the corresponding healthy joint.

As is known, the theories cited above on the antibacterial properties of certain blood components and cells have been repeatedly opposed, and have even to-day so many enemies that none of them enjoys general recognition. Most of these are of no interest for our purposes, and I can confine myself to one objection by Spronk,[1] which he has raised against the observations of Hamburger and Nötzel in regard to the bactericidal property of the congestion œdema, and apparently not unjustly. Just such bodily parts as are in an œdematous condition are preferably attacked by bacterial diseases. This is so old a surgical experience that it is unnecessary to spend any more time on it. To this must be added that I myself had to report grave erysipelatoid inflammation and suppuration, which occurred in extremities subjected to congestion hyperæmia. I soon, however, found out, as already mentioned on p. 73, that there existed an error in technique, and that these undesirable accidents occur only when an excessive and prolonged disturbance is produced by the bandage. I have therefore repeatedly warned the operator that for prolonged employment only hot congestion is effective, while a cold one may have bad consequences, as it may lead to serious circulatory disturbances. I can report that the hot congestion, instead of leading to erysipelatoid and other infectious diseases in

[1] Spronk, "Weekblad van het Nederl. Tydschrift vor Geneskunde," 1898, No. 1. The original contribution was not accessible; I know it only from a citation.

the congested limbs, on the contrary, opposes these diseases most effectively, and for many of them it is the best remedy.

We had to learn in such cases, as in many methods of physical therapy—one need only reflect upon the application of water for curative purposes—that the useful and harmful degree of a remedy frequently are close to each other, and that one must know and measure his remedies in order to do good. The scientific confirmation of these facts is contained in the above-mentioned excellent contribution by Nötzel, who demonstrated that in order to kill bacteria new blood and new transudate are always necessary, and that serious disturbances of circulation and chronic œdema, instead of preventing, tend to favour infection. For this reason I do not employ prolonged hyperæmia in infectious diseases. I will explain how to proceed in the individual affections in the clinical part of this book.

Besides, it is often forgotten that different things are to be understood by the term "œdema." The transudate in chronic heart and kidney diseases is something entirely different from the exudate of acute inflammation.

The important proof that inflammatory œdema itself, in grave infectious diseases, is free from bacteria has been but recently established by Joseph.[1]

I am well aware that my views on the favourable effect of congestion hyperæmia on infectious diseases are in direct contradiction to the prevailing doctrines on their treatment. For in surgery it was considered a positive axiom that blood-stasis is highly injurious to all inflammatory processes, and that the alpha and omega of treatment was contained in the removal of the stasis! For this reason, when a description of congestion hyperæmia as a means to produce new bone formation was given, it was stated that the remedy is "self-evidently" to be entirely out of question in inflammation of the concerned extremities, even in chronic tuberculous inflammation. The correctness of this opinion seemed to be borne out from the clinical observations of the so-called hypostatic pneumonia, which was looked upon as a consequence of the sinking of blood to the dependent parts

[1] Joseph, "Einige Wirkungen des natürlichen Ödems und der künstlichen Ödemisierung. Ein Beitrag zur Stauungstherapie" (*Münch. Med. Wochenschrift*, 1905, No. 40).

of the lungs. To this must be added the fact that the so called antiphlogistic regimen (which is designated by the three rules "rest, high posture, and ice for all inflammations") immediately improved grave and dangerous forms of inflammation of the extremities.

How can these peculiar contradictions be unified? First, it must be said with regard to hypostatic pneumonia that we have to deal with special conditions. As it is produced by an exhaustion of the heart-force, therefore it occurs in debilitated individuals whose natural capability of reaction has suffered: and, second, it does not appear to me as proven that it is the hypostasis which is the real cause, and not other factors, such as deficient aeration, and therefore deficient purification of the concerned parts of the lungs, while the hyperæmia is perhaps only a secondary condition.

But there still remains the undeniably favourable effect of the antiphlogosis, of which I myself have been convinced many times, for I have been trained in one of the strictest antiphlogistic schools. Thus I found myself unfortunately holding dissentient views. I have long considered inflammation to be useful, and acted accordingly in many cases; I did not combat the inflammation, I supported it. For the past eleven years I have made use of congestion hyperæmia, the very opposite to antiphlogosis, the former representing the now best-known agent for increasing inflammation. This process I now apply to a series of acute inflammatory diseases, after having previously used it in chronic affections, and in this I have advanced from year to year. But on the whole I cease with the non-suppurative or incipient acute suppurative inflammation. Though I had in former years successfully treated a few cases of advanced suppuration by congestion hyperæmia, the fear for the so-called experience prevented me principally from applying this agent in the grave and gravest forms of suppurative inflammation. And yet I had to come to that by logical reasoning. For it is but a small step from a gonorrhœic and pyæmic suppurating joint to a lesion due to trauma and osteomyelitis, from lymphangitis and incipient panaris to the grave phlegmons threatening life and limb which I have taken for some time, and have had no cause to regret.

Certainly it appears at first sight self-evident that the

high posture must act favourably, and congestion hyperæmia unfavourably, in the grave infectious diseases of the extremities which *per se* are inclined towards pronounced circulatory disturbances and venous stasis, so that gangrene is either threatened or already established. But I shall show in the course of this work, by cases which prove it, that false views have been entertained in this respect. To assert that congestion of blood—granting that it is not excessive—disturbs nutrition is just as false as the assertion that it produces pain. This is proved by a series of our cases, where we succeeded in preserving bodily parts, which according to our previous experience were doomed to death. Correctly executed congestion hyperæmia means an improvement of, and not an injury to, nutrition. It is not the inflammatory stasis that produces necrosis, but the primary injury and essentially bacterial poisons; these also are responsible for the pain. The slowing of the blood-current in inflammation is intended to prevent the necrosis by rendering the bacteria and their toxins harmless, and to increase the nutrition of the part.

I do not deny that there are cases where Nature overreaches the mark, and the inflammatory hyperæmia and slowing of the current may become so intense that their diminution rather than their increase is indicated. However, these cases are extremely rare.

I am therefore convinced that antiphlogosis, in its strict application, was one of the most pernicious errors of our science, and that the time is not far distant when it will be looked upon as one of the harmful, false teachings in medicine. It is all the more striking because this method has enjoyed for so long a period the unlimited recognition of physicians. It is, therefore, proper to investigate whether, as is the case with the "derivantia," a false theory did not support a correct practice—that is to say, whether some individual measures employed in antiphlogosis had not a true basis.

As regards the ice-bag,[1] I consider it, if applied for some time, to be a remedy which does not produce anæmia, but hyperæmia, therefore the opposite from what has

[1] This section on the ice-bag has already been published in the first edition of this book; nevertheless it has been repeatedly asserted (especially by Homberger, *Arch. f. Klin. Chir.*, 1906, vol. lxxx., No. 4) that I rejected the ice-bag, and had overlooked that it in reality also hyperæmizes.

been expected of it. It is known that the intense cold obtained from the ice-bag produces at first a transient anæmia, then a lasting hyperæmia. One need only observe the skin which has been exposed to this remedy for several hours. The cold, as is proven by the well-known experiments of v. Esmarch, Schlikoff, and others, penetrates deeply into the tissues, and we can assume that hyperæmia follows the stimulation by the cold also into the deep parts. The hyperæmia is necessarily passive, because otherwise it would not be possible for the cold to penetrate so deeply, as the rapid blood-stream associated with active hyperæmia would quickly equalize the difference in temperature. Finally we must remember the fact that frequently we obtain identical results with apparently or really opposite remedies. Thus, some physicians treat the chest of a patient suffering from pneumonia with an ice-bag, while others apply a warm poultice, and both obtain good results from each, particularly as regards the relief of pain. Theoretically, a really opposite yet favourable result can be expected from both of our remedies somewhat in this manner: Of late an attempt has been made to treat bacterial diseases in two different ways: first by killing the bacteria, as in antisepsis; second, by annihilation or agglutination of the injurious toxins, as in the antidiphtheritic serum of v. Behring. Now let us imagine, on one hand, the congestion hyperæmia as a bactericidal, on the other hand the antiphlogistic regimen as a remedy slowing the absorption and effect of the toxins, and we have reached in two entirely different ways one and the same thing, namely, the favourable influence on the disease. That the effect of the toxins, and especially their absorption, are strongly influenced by the antiphlogistic remedies is evident from numerous contributions to be mentioned in the chapter on Resorption. We shall there see that in this respect the opposite remedies, high posture and congestion hyperæmia, meet.

From these statements it is clear that the contradictions treated above are not necessarily as irreconcilable as they appear to be. However, we have here entered the domain of theory, and in practical medicine experience plays the main rôle. And I believe I have gained enough of the latter to be able to assert that in reality antiphlogosis does not

have so decidedly favourable an effect as one was led to believe. If we, for instance, treat an acutely or subacutely inflamed joint, which has no grave disturbances of circulation, antiphlogistically, the pain disappears rapidly, inflammation and fever diminish, but, as a rule, the treatment is prolonged, resulting too often in ankylosis. If we, however, treat the same joint with congestion hyperæmia, the pain disappears, as a rule, more rapidly, fever frequently diminishes immediately, and what is more striking is the resulting increased mobility of the joint. Furthermore, the entire course of the disease is far shorter. I cannot help considering that in such cases we have actually done harm by an antiphlogistic regimen. We have suppressed the phenomena disagreeable to the patient, but at the same time also the useful inflammatory reaction, thus prolonging the disease, and, what is most important, causing the joint to become stiff. The result from the antiphlogistic regimen was therefore in reality a failure. On the other hand, antiphlogistic treatment is suitable and useful when Nature overreaches the mark with the phenomena of inflammation, especially with hyperæmia, as I have described. Elevated posture is still more useful in chronic œdema, to the harmfulness of which I have repeatedly called attention.

Previous to my employment of congestion hyperæmia for infectious diseases, I made use of active hyperæmia for the same purpose. The first experiments with hyperæmia by hot air were made in the year 1891 for a pronounced infectious disease—tuberculosis. I have described in my contribution of 1893 the complete failure of these experiments. With one exception I have been able to observe only changes for the worse. These observations have been later confirmed by Thiem,[1] who has had the same experience. I found only two reports in the literature on the treatment of tuberculosis with hot air.

Clado,[2] who, as I have already mentioned, employed hot air for the treatment of tuberculous affections of the joints at about the same time as I did, with a view of killing the tubercle bacilli in the manner of Tyndall's "fractional

[1] Thiem, "Ueber Thermotherapie bei der Nachbehandlung Unfallverletzter" (*Zeitschr. f. Unfallheilkunde*, 1900, No. 3).

[2] "Traitement des lésions tuberculeuses accessibles par la température élevée" (Report of the French Surgical Congress of 1891).

sterilization," reports that he has cured four out of six joints affected with tuberculosis, which he treated daily for one hour at a temperature of 110° C. Further details he does not furnish.

Wilson[1] has treated many cases of tuberculosis of the joints with hot air, but has at the same time fixed the joints. He holds the view that the disease is favourably influenced by the treatment, but cannot positively assert this, and does not know which of the two remedies has been effective.

The fact that one hears nowadays so little about the treatment of tuberculous joints with hot air, which had become so popular, seems to indicate that the results generally have been harmful; for the remedy certainly has been used for all possible joint troubles, hence also for tuberculosis. I do not believe that my warning, published in 1893, had a deterring effect; it seems that it either did not become known, or was forgotten when Tallerman's apparatus drew the attention of wide circles to hot-air therapy. Similar failures were experienced by me with hot air when I commenced to treat by hyperæmia acute inflammation of joints. To be sure, I only used it in four or five cases of acute gonorrhœal or rheumatic arthritis, but throughout with moderate results. There either was no improvement or the affections became worse. At any rate, the effect of congestion hyperæmia here proved considerably superior.

Wilson, too, has had no success in the treatment of acute articular affections. He expressly states that hot-air therapy has no favourable effect on acute and chronic gout, acute rheumatism, and in the rheumatoid arthritides.

Numerous reports on the favourable influence of hot air on gonorrhœal inflammation of joints can be found in literature. But it is not stated whether these really were acutely inflamed joints or only the sequelæ, especially stiffened joints. In one contribution only I do not know whether the author has really treated with hot air such acutely inflamed joints. Löwenhardt[2] states that he "has employed in all stages of gonorrhœal arthritis hot air, and has not see an injurious effect from it." Immediately afterwards,

[1] Wilson, "Hot Air in Joint Diseases" (*Annals of Surgery*, vol. xxix., 1899).

[2] Löwenhardt, "Zur Pathologie u. Therapie d. gon. Gelenkerkrankungen" (*Wiener Med. Presse*, 1898, No. 45).

however, he admits that "only when the temperature was high, and in processes inclined to the formation of abscesses. I had no opportunity or did not feel justified in proceeding thermically." At any rate, even from this contribution, we do not know whether Löwenhardt has obtained favourable results in acute or only subacute inflammation of the joints.

Recently Buchner,[1] in reference to the theory established by him, has expressed the view that the active hyperæmia which he believes he procured by means of an alcohol bandage has a greater bactericidal effect than the passive form obtained by blood-stasis. I have demonstrated above that Buchner has still to prove that the hyperæmia which the alcohol dressing produces also in the deep parts is really active, and not a passive hyperæmia, close to the inflammatory one. Everything seems to indicate that the latter is the case.

Finally, Ullmann[2] has reported good results obtained from the treatment by hot air of infected wounds and bacterial ulcers. He attributes the good results to the bactericidal properties of the active hyperæmia produced by hot air. It is noteworthy that the infectious affections treated by Ullmann were only superficial ulcers. These I have treated with hot air in the very beginning of my experiments, and in my first contribution I reported an interesting case. Nevertheless, it seems very doubtful to me whether we have to deal with a bactericidal effect of the active hyperæmia, and I have repeatedly expressed these doubts. Here other influences are brought into play—namely, the bactericidal effect of the heat itself, which cannot be doubted because of the superficiality of the ulcers, the acceleration of demarcation in gangrenous and necrotic processes, and the vigorous formation of granulations.

If we investigate the question of how Nature proceeds when it produces its inflammatory hyperæmia, we learn that in all inflammations it diminishes the blood-stream after a transient acceleration, and that this diminution remains throughout the period of the inflammation.[3] If we, there-

[1] *Loc. cit.*

[2] Ullmann, *Wiener Klin. Wochenschrift*, 1901, No. 1.

[3] Some investigators do not recognize the slowing of the blood-current in inflammation. Recently Homberger ("Eine physio-pathol. Studie über venöse Hyperämie, *Archiv f. Klin. Chir.*, 1906, vol. lxxx., No. 4) has

fore, look on the entire inflammatory process as something useful, we cannot avoid taking into consideration the diminution of the blood-stream, and if we wish to support Nature's healing we must not disturb it, but, on the contrary, supplement it.

I have already mentioned that it is often difficult to determine whether in the production of hyperæmia we have to deal with an acceleration or a diminution of the blood-stream. This is especially so when we render inflamed parts hyperæmic. For, as observation with the microscope has shown, the inflammatory irritation, the effect of which is totally unknown to us, is capable of diminishing an originally accelerated blood-stream, and of keeping it thus. All explanations which have been made for this peculiar phenomenon are entirely unsatisfactory. (I have shown in an earlier contribution[1] that an inflamed area, even under artificial bloodlessness, retains the blood with great tenacity, and absorbs it again with great force, if it is driven out artificially. This simple and easily demonstrable important fact is completely ignored in the teaching of inflammation, because most physicians in the representation of the circulation consider as scientific only that for which they can offer crude hydrodynamic explanations.) But it is certain that agents which produce active hyperæmia *per se*, in inflamed parts produce passive hyperæmia, as the blood-stream in the vessels in the inflamed part becomes slower. The active hyperæmia must not predominate, otherwise it will disturb the natural process of reaction. From this it follows that we must not employ an agent producing too intense active hyperæmia (and such hot air decidedly is), while a moist warm poultice or a hot compress may increase the natural process of inflammation, because they accelerate the blood-stream to a lesser degree, and are therefore more suitable in inflammation.

That I was right in this view repeatedly expressed is also

vehemently disputed it. It would lead me too far to discuss this contended question. In my opinion, the one fact that the artificial slowing of the blood-current greatly increases all phenomena of inflammation shows better than all sorts of uncertain and self-contradictory experiments that in inflammation the slowing of the blood-current plays the decisive rôle.

[1] Bier, "Die Entstehung des Kollateralkreislaufs" (*Virchow's Archiv*, vol. cliii., 1898, p. 451).

evident from the fact that Ullmann[1] has later replaced the hot air with a "hydrothermo-regulator" in the acute diseases just mentioned, which acts after the manner of those old remedies. Following Welander's method, he inserts moist cotton between the heat-giving body and the treated bodily part, and considers this method of applying heat much more efficient for the diseases mentioned. To this category belongs my above-cited observation that a cupping-glass, which produces a bright red arterial hyperæmia in a healthy portion of the skin, causes a dark venous hyperæmia when placed over a lupus—that is to say, chronically inflamed skin. Among extraordinarily violent ebullitions, the hyperæmia following the injection of Koch's tuberculin, it seems to me, can be similarly counted, and it is possible that part of the changes for the worse are due to this fact.

It is opportune to point on this occasion to the fact that, after enormous exertion associated with functional active hyperæmia, infectious diseases frequently appear in the overtaxed parts—*e.g.*, tuberculosis and gonorrhœa of the joints after excessive use of the extremities. I will avoid pressing this conclusion, for those observations can be explained much more simply by the unusual strain and injury of the tissues which is the consequence of any over-exertion. The most one can say is to maintain that the active functional hyperæmia is not capable of warding off the development of those diseases.

It seems to me to be a constant phenomenon in Nature that in any necessary function the organism concentrates itself entirely on it, being but little able to accomplish two important things by means of the same agent. We see that an inflamed part is functionally quiescent—in my opinion, in order not to dissipate its forces uselessly with a view to maintaining them at its disposal against the harmful cause of the inflammation. We all agree that tissues well supplied with blood do not easily become attacked by infection. In marked opposition to this, however, observe how engorged growing areas preferably become victims to the bacteria—*e.g.*, the growing bones of infants to acute osteomyelitis, the

[1] Ullmann, "Zur Thermotherapie mittelst konstanter Wärme" (*Zeitschr. f. Diät. u. Physik. Ther.*, vol. vi., p. 603, 1903); and "Zur klinisch-therapeutischen Verwertbarkeit der konstanten Wärme" (*Wiener Klin. Rundschau*, 1902, Nos. 23-25).

mammary gland of the pregnant and nursing woman to mastitis. Thus, the urethra of an individual affected with chronic gonorrhœa becomes acutely diseased when he practises coitus, or is tortured by erections; but artificial hyperæmia, as I have shown, and especially the kind shown in the erected organ, has an astonishingly curative effect on the gonococcic infection. The point being, the entire energy of the organism is directed towards one object (growth, labour, suppression of an infection).

Examples of this kind could be cited in large numbers from all domains of medicine, even from the psychic territory. As is well known, there are few men who can at the same time write on one subject and discuss another. This ability has been looked upon as a sign of special mental greatness (Cæsar, Napoleon).

Something similar with respect to a special case has been expressed by Preyer. This physiologist assumed that the ganglionic cells of the central nervous system establish chemical combinations with the narcotica, for the decomposition and removal of which the cells must exert their total living energy and abandon their normal functions during that time, and thus fall asleep until they have succeeded in the expulsion and destruction of the poison.

After all reported experiences, it seems to me logical from a purely theoretical standpoint to give the preference to congestion hyperæmia in the selection of the various forms of hyperæmia for the treatment of inflammatory diseases, as it imitates more faithfully the natural healing process of inflammation, and also increases it. My practical results are in accord with this theoretical conception. It is beyond doubt that occasionally active hyperæmia can be, and has been, successfully employed, just as I am positive that the most intense forms of active hyperæmia can be injurious under certain circumstances in acute inflammation, and that congestion hyperæmia is, to say the least, the superior method in chronic and subacute inflammations. It appears to me strange that more recent investigators now take up the matter and apply hyperæmia after certain fixed theories, as for a long time no attention has been paid to my explanation of the described remedies as producing hyperæmia. One attacks the bacteria with serum, the other with leucocytes,

the third with carbonic acid, etc., without considering that we have to deal with unproved theories. Though these theories are so important and fruitful that I would not relinquish them under any circumstances, yet they may lead to risks if practically applied in their one-sidedness. We should be in danger of reaching a stage similar to that which prevailed in hydrotherapy, in which all possible unproved physiological experiments have been applied in practice, and conclusions drawn from methods which have long ago ceased to be recognized by physiologists.

I reply to those physicians, who, depending on their preconceived theoretic opinions, consider the serum or the leucocytes, etc., as the essential component of inflammatory hyperæmia and its sequences, as follows: For our practical purposes I will define for once all processes which serve to preserve man and his species as physiological, all which harm and destroy him as pathological. (The teaching of physiology textbooks, that physiology is the science of the life-phenomena of organisms, we practitioners cannot use, for poisoning and death are then also physiological.) If this definition—of course, only applicable to the practical processes of the practising physician—is proper, then inflammation is an exquisitely physiological process: the struggle of the body against the attack of an intruded, dangerous enemy, whom it must not only destroy, but whose ravages and destructions it must make good again (regeneration in inflammation). All such physiological processes are highly complicated, and when one holds that of all the phenomena of inflammation, for example, the blood-serum alone, or the leucocytes alone, which enter that tissue, are responsible for the healing, it is as if one should assert that only the gastric juice or only the pancreatic saliva complete the digestion and assimilation of food, while everything else that happens to the food on the way from mouth to anus—mastication, salivation, deglutition, the excretion of all other digestive juices, etc.—were more or less useless secondary functions.

This one-sidedness of the bacteriologists reminds me of the pathological anatomists of the time when Cohnheim made his famous discovery of the emigration of the white blood-corpuscles. At that time the problem of inflammation was considered positively solved, so much were the eyes

of the physicians blinded by this brilliant discovery. They even went farther. The leucocyte could do everything. It was the elemental organism which became—depending on necessity—connective tissue, muscle, nerve, etc. Now we think more calmly. We know that this emigration of the leucocytes is only one phenomenon of inflammation, and that its real nature is still extremely obscure.

If we conceive of inflammation as a physiological process, we can understand the great dilemma of the pathological anatomists, the problem of considering inflammation entirely anatomically, which conception has already led to the unfortunate proposition to abandon any further effort. Inflammation is as little anatomical as, to revert to the comparison, is digestion, especially as a large number of the phenomena of inflammation disappear with death.

Now at this time we have no better and more effective remedy to support and increase the useful and healing inflammation in all its phenomena than the congestion hyperæmia, which we produce with the bandage or with the suction apparatus. The passive hyperæmia is suitable for acute—*i.e.*, bacterial—the active for chronic non-bacterial diseases, and the consequences of the latter. I differentiate here intentionally between passive and active, and not between venous and arterial hyperæmia. For I deem it probable that a little more carbonic acid or oxygen in inflammatory hyperæmia plays a less rôle than the slowing and widening of the current. For this latter brings the injured tissues into more intimate relation with the healing components of blood (serum, leucocytes, etc.) than the rapidly flowing arterial current.

RESORPTIVE EFFECT OF HYPERÆMIA

For some time I have made use of active hyperæmia produced by hot air for the purpose of absorption. I learned early that in chronic affections of the joints which I treated alternately with active and passive hyperæmia, the former quickly removed the œdema produced by the latter. On this experience I employed active hyperæmia in the treatment of elephantiasis and the œdema following the healed

fractures of the extremities. If a resorptive effect is desired, hot air must not be applied too long, as otherwise it will produce œdema. I have reported in my first contribution that limbs exposed to hot air of 100° C. for eight to ten hours daily became strongly œdematous. We again see here the peculiarity, already mentioned, of physical remedies that yield variable results depending on the duration and intensity of their application, a feature which will still further demand our attention.

The resorptive effect of active hyperæmia is in full accord with our modern scientific knowledge of the channels of absorption, for we know that almost the entire absorption of watery substances and bodies soluble in water takes place through the blood-capillaries and not through the lymph-channels, as was generally believed. This view is undisputed as far as the gastro-intestinal digestion is concerned, so that it is unnecessary to cite proof from the special literature, a perusal of a modern textbook on physiology being sufficient for that. Resorption of water, salts, dissolved carbohydrates, peptones, and some unchanged, soluble albuminous bodies, takes place almost exclusively through the blood-circulation. Small quantities of these substances have been found in the lymph-channels only after the ingestion of large quantities. On the other hand, fat, whether taken up in a saponified condition or in the form of fine granules, is carried off almost exclusively by the lymphatics, but a very small portion, apparently, directly entering the blood.

Similar conditions prevail in regard to the resorption of materials from the tissues and cavities of the body. It has cost much time and difficulty before this conviction was reached. And, indeed, it seems peculiar at the first glance that remedies, dissolved in water and injected into the very openings of the lymph-spaces, are not taken up and carried off by them, but by the bloodvessels, which are separated by a wall. One would rather think that the open lymph-spaces of the abdominal cavity, which v. Recklinghausen has demonstrated as especially numerous at the diaphragm, would take up fluids instead of permitting them first to pass through the wall of the blood-capillaries. Numerous experiments, however, have shown that this

latter is indeed the case, and that resorption occurs in a similar way as it does in the digestive tract. I will omit the fairly old experiments[1] from which the observers concluded that tissue resorption depended on the general and local blood-volume, and quote from the numerous contributions some of the more recent and important ones which offer decisive proof.

Orlow,[2] a pupil of Heidenhain, observed that during the absorption of fluids and salts, which he had injected into the abdominal cavity, neither increased in quantity in the lymph taken from the thoracic duct. Since fluids and salts disappeared from the abdominal cavity during the observation, they must have been taken up by the blood-capillaries.

Starling,[3] during the resorption of sodium indigo sulphate from the pleural and abdominal cavities, found the drug more in the urine than in the lymph.

Heidenhain,[4] in a contribution in which he defends Orlow's results against attacks made by Cohnstein, says :

"On the strength of Orlow's experiments and my own experience, I am convinced, now as before, that the most important channels of absorption of the peritoneal cavity are the blood-capillaries, though the possibility exists—not disputed by Orlow—that the lymph-channels of Recklinghausen carry a small quantity of fluid to the thoracic duct."

Hamburger[5] found that after ligature of the thoracic duct absorption from the abdominal cavity took place just as rapidly as when the lymph-current was unobstructed. "From this follows by exclusion that the bloodvessels must be held responsible for the resorption—if not totally, at least to a great extent." He tries to prove by the following experiment that the same condition prevails in regard to tissue resorption : He clamped the aorta of an animal below the renal artery with forceps, and injected a solution of iodide of potash in one of the hind-legs, the vena cruralis of which he had exposed and provided with a small tube

[1] S. bei C. Ludwig, "Lehrbuch der Physiologie des Menschen," vol. ii., second edition, 1861, p. 565.

[2] Orlow, "Einige Versuche über die Resorption der Bauchhöhle" (*Pflüger's Archiv*, vol. lix., p. 170).

[3] Cited after Orlow.

[4] Heidenhain, "Bemerkungen und Versuche betreffs der Resorption in der Bauchhöhle" (*Pflüger's Archiv*, vol. lxii., p. 320).

[5] Hamburger, "Ueber die Regelung der osmotischen Spannkraft von Flüssigkeiten in Bauch- und Pericardialhöhle" (*Du Bois-Reymond-His'sches Archiv, Physiol. Abt.*, 1895, p. 281).

which permitted the outflow of blood from the foot end. He found iodide of potash in the venous blood of the leg. This must have been absorbed by the blood-capillaries, for if the lymph-current had carried it into the blood, it could not have reached any farther in the circulation than the place of ligature of the aorta.

Asher[1] made a similar experiment. He ligatured the abdominal aorta, exposed the arteria and vena cruralis, severed them, and introduced canulæ. He injected a solution of sodium iodide into the tissues. He now caused an artificial blood-current to pass through the extremity excluded from the circulation, and found iodine in the blood coming from the vein. This could only have been taken up by the capillaries. Asher was able to demonstrate resorption of sodium iodide by the capillaries by several experiments made in a different way.

J. Munk[2] proved tissue resorption through the blood-channels thus: He ligatured the lymph-trunk of the neck, and incised it above the place of ligature, so that the entire lymph of the head was led outwards. Then he repeatedly injected poison under the scalp of the animals. He could note no important difference in regard to appearance and course of poisoning, irrespective of whether lymph had escaped or not. There should have been a difference if the lymph-roots had absorbed the poison. The poison (strychnine) could not be demonstrated in the lymph.

Though there could scarcely remain any doubt, after these experiments, that indeed the bloodvessels are the means by which almost the entire resorption of substances soluble in water from the tissues and cavities of the body takes place, lately my assistant, Professor Klapp,[3] proved this conclusively. He happily chose sugar of milk for experimentation. Voit[4] has shown that every particle of sugar

[1] Asher, "Ein Beitrag zur Resorption durch die Blutgefässe" (*Zeitschrift f. Biologie*, vol. xxix., p. 247, 1892).

[2] J. Munk, "Zur Kenntnis der interstitiellen Resorption wasserlöslicher Substanzen," Verh. d. Berliner Physiol. Ges., twelfth session, April 5, 1895 (*Du Bois-Reymond-His'sches Archiv, Physiol. Abt.*, 1895, p. 387).

[3] Klapp, "Ueber Bauchfellresorption, Mitteilungen aus den Grenzgebieten der Medizin und Chirurgie," vol. x., brochures 1 and 2.

[4] Voit, "Untersuchungen über das Verhalten verschiedener Zuckerarten im menschlichen Organismus nach subkutaner Injektion" (*Deutsches Archiv f. Klin. Medizin*, vol. lviii., p. 523).

of milk hypodermically injected in any desired place can be found in the urine. Besides, this substance can be easily demonstrated quantitatively with the polarization apparatus. We have, therefore, in sugar of milk a substance which permits exact quantitative determination of the extent of excretion, on account of which, experiments of resorption reached an hitherto unknown exactness.

Klapp ligatured in dogs the ductus thoracicus and the ductus lymphaticus dexter, and thus excluded all lymph-channels which could pass sugar of milk injected into the abdominal cavity into the blood. In spite of this, the sugar of milk appeared in the urine in the same time as was observed in the same animals a few days previously, while their lymph-channels were normal. Thus, the unassailable proof is established that substances soluble in water may be taken up by the circulation solely. Neither Klapp nor the above-mentioned experimenters deny that the lymph-channels, too, may participate in the process of resorption, but inasmuch as their exclusion quantitatively does not retard absorption, they evidently play but an unimportant rôle, and do not possess the importance as regards the resorption of water, salts, and substances soluble in water, ascribed to them in the famous works of v. Recklinghausen[1] and Wegner.[2] On the other hand, v. Recklinghausen has just as conclusively shown that small corpuscular elements (milk, emulsions, blood, cobalt, Indian ink) are taken up by the lymph-channels of the diaphragm. These observations have been confirmed by several authorities. Thus, Sulzer[3] found kernels of wheat, which he had injected into the abdominal cavity, in the lymph-channels on the chest side of the diaphragm and in the thoracic duct, and believes that they get there without any medium, being but partially taken up by the leucocytes and carried off.

Similar results were reached by Muscatello.[4] He found

[1] v. Recklinghausen, "Zur Fettresorption" (*Virchow's Archiv*, vol. xxvi., p. 172).

[2] Wegner, "Chirurgische Bemerkungen über die Peritonealhöhle mit besonderer Berücksichtigung der Ovariotomie" (*Langenbeck's Archiv*, vol. xx.).

[3] Sulzer, "Ueber den Durchtritt corpuskulärer Gebilde durch das Zwerchfell" (*Virchow's Archiv*, vol. cxliii., p. 99).

[4] Muscatello, "Ueber den Bau und das Aufsaugungsvermögen des Peritoneum" (*Virchow's Archiv*, vol. cxlii., p. 327).

that the diaphragm is the only part of the serosa of the abdominal cavity intended for the resorption of granular substances. This absorption takes place with great rapidity. He believes that fine granular substances and some pliant bodies pass through the endothelial cells in a free condition, while rigid bodies are carried off, as a rule, by migratory cells.

We can, therefore, formulate the following as an axiom, established by many scientific experiments : The resorption of water and substances soluble in water in gastro-intestinal digestion and tissues and cavities of the body takes place essentially through the bloodvessels ; the resorption of the smallest bodily elements, on the other hand, essentially through the lymph-vessels.

For us practitioners the following question is of the greatest importance : Can we artificially influence this resorption, as I have already asserted, and can this influence, tested in practice, be demonstrated scientifically ? Alas ! as I have shown, we know so little about the influence of the lymph-current that the question whether we can aid in the resorption of bodily elements must be excluded from scientific discussion. We are for this reason limited to the question : How does the influence of the blood-current affect resorption ?

We have some old scientific observations on this subject. During the era of venesection the influence of the general volume of blood on resorption was thoroughly discussed. As this is of no concern to us, and since only the later contributions refer to a local influence on resorption, I will at once refer to these.

When v. Esmarch's bloodless surgery, on account of its great successes, stirred the minds of the surgeons, the advantages and disadvantages offered by this process were zealously discussed. To that time belongs a publication by Wölfler,[1] in which it is intended to show the lack of danger from strong antiseptics applied to wounds which were kept bloodless. Though intended for a different purpose, this publication is of great interest to us, because it plainly shows one of the influences of hyperæmia on resorption. Wölfler

[1] Wölfler, " Ueber den Einfluss der Esmarch'schen Blutleere auf die Resorption flüssiger Stoffe " (*Langenbeck's Archiv*, vol. xxvii.).

produced a wound at the ankle-joint of dogs, dropped on it 3 grammes of a watery solution of potash ferrocyanide, and showed that the remedy could be demonstrated in the urine after thirty minutes only. If he made the extremity bloodless, and applied to an equally large wound 12 grammes of the dye, as long as the depletion was maintained no reaction appeared in the urine ; ten minutes after removal of the depletion reaction occurred in the urine. From this Wölfler concluded that the resorption of the dye into the circulation takes place more rapidly after removal of the rubber producing the bloodless condition than under ordinary conditions.

Wölfler tries to meet the objection that during the bloodless condition the dye may have spread below the rubber tubing in the extremity excluded from the circulation by diffusion and osmosis, and for this reason enters the circulation more rapidly on releasing the constriction, by the following method : He applied the constricting rubber in the inguinal region, and dropped the dye on the wound at the ankle-joint. After thirty-five minutes he applied a second piece of rubber tubing two fingers above the wound, and removed the first. In spite of this no reaction occurred in the urine in the usual time. But after the second constriction was released, the substance was found six minutes later in the urine. Wölfler concludes that below the constriction no imbibition with dye takes place in the extremity which is excluded from the circulation. Experiments with strychnine led to the same result.

As is well known, there occurs after artificial depletion an enormous arterial (the so-called reaction) hyperæmia. Thus we have an illustration of how arterial hyperæmia considerably accelerates the resorption of a substance soluble in water. The latter appeared in the urine in from six to ten minutes, though this takes thirty minutes under ordinary conditions.

Klapp[1] justly offers some objections to the value of these experiments. He thinks that it is contrary to our experience on diffusion, osmosis, and imbibition, to allow that the applied liquid could not saturate the tissues in the vicinity

[1] Klapp, "Ueber parenchymatöse Resorption" (*Archiv f. Experimentelle Pathologie und Pharmakologie*, vol. xlvii., p. 86).

of the wound without the blood-current, and cites facts which prove that dissolved substances spread in the tissues even after interruption of the circulation. The fact that Wölfler, after applying the second constrictor two fingers' breadth above the wound, found no reaction in the urine is no proof that the immediate vicinity of the wound was not thoroughly saturated with the dye. Klapp further calls attention to the fact that all experiments of resorption with dyes and poisons are uncertain, because they can be demonstrated only qualitatively by phenomena of poisoning and reactions, but never quantitatively. It was this that led him to the above-mentioned introduction of the use of sugar of milk for the purpose of experimenting on resorption, as this substance can be demonstrated quantitatively at any period of the experiment with great ease. This process is evidently so superior to all others that I will limit myself to a short reproduction of the theories adopted by Klapp with regard to the influence on resorption of agents producing hyperæmia.

Klapp first of all demonstrated that active hyperæmia produces a decided acceleration of resorption. He injected sugar of milk hypodermically into one of the hind-legs of a dog, and then placed the extremity for a period of twenty minutes to two hours in a hot-air apparatus. He found that, from among eighteen experiments, in two instances insignificant, scarcely noticeable differences became evident. In the rest resorption took place two to three times faster. From experiments which Klapp made on himself and on students, he learned that hot air regularly produced an increase of resorption, but in a less degree than that observed in dogs. Klapp showed in another contribution[1] that resorption in the abdominal cavity can be accelerated by hot air. Resorption was always present, but not as considerably as when the remedy was injected in the leg and subjected to the same conditions. This is easily understood, for the hot air has an entirely different effect on a small limb than on the large abdomen.

It might be suggested as invalidating these experiments on the effectiveness of the hyperæmia, that they are un-

[1] Klapp, "Ueber Bauchfellresorption" (*Mitteilungen aus den Grenzgebieten der Medizin und Chirurgie*, vol. x., brochures 1 and 2).

reliable, because the heat produces numerous changes apart from the hyperæmia. This objection seems justified, because the influence of heat and cold on resorption has been demonstrated long ago. Thus, Sassetzky[1] observed that certain drugs (pilocarpine, morphine, iodide of potash, ferrocyanide of potassium) were more quickly absorbed by the human body if he raised the temperature of the skin at the place of injection to 39° C., or if he heated the solutions; on reducing the same place to a temperature of 12° C. by freezing agents, resorption was slower, the drugs appearing in the urine three or four minutes later than if the former method was employed.

v. Kóssa,[2] arguing from the earlier experiments of Luchsinger and Claude Bernard, made the following experiments: He injected into the auricles of rabbits, which he cooled with freezing agents of cold water (hydrant water at + 7° C. suffices), the strongest poisons—potassium cyanide, strychnine, picrotoxin. All these animals remained alive and well if the auricle was kept cool one to one and a half hours, while the other animals either died or had to pass through the most intense forms of poisoning. He believes that during the exposure to cold, absorption takes place either not at all, or at least so slowly that the drug is gradually excreted without producing phenomena of poisoning.

Klapp, too, could considerably retard the excretion of sugar of milk which he had injected into the tissues and into the abdominal cavity if he produced cooling by ice-water or with the ice-bag.

We know that warmth produces hyperæmia, and, according to my conception, arterial hyperæmia, while cold produces anæmia, or, if applied for a long while, congestion hyperæmia. These experiments, therefore, are in accord with our view that arterial hyperæmia accelerates resorption, while anæmia retards it. Several other interesting experiments of Klapp confirm this view. He found that wide opening of the abdominal cavity and short forward displacement of the intestines—up to fifteen minutes—accelerates resorption

[1] Sassetzky, "Ueber den Einfluss erhöhter und herabgesetzter Temperaturen auf die Resorption an der Stelle einer subkutanen Injektion" (*St. Petersburger Med. Wochenschrift*, 1880, Nos. 15 and 19).

[2] v. Kóssa, "Die Resorption der Gifte an abgekühlten Körperstellen" (*Archiv f. Experimentelle Pathologie und Pharmakologie*, vol. xxxvi., p. 120).

in the abdominal cavity, and that this is retarded after prolonged displacement. We know from numerous observations that a large abdominal incision and displacement forward of the viscera produces intense hyperæmia in the latter. At first the hyperæmia is an active one ; later, in consequence of dehydration, cooling off, and other injuries, it becomes passive. According to Hildebrandt,[1] the active hyperæmia lasts in rabbits about twenty minutes, when it changes to the passive form. This agrees fully with Klapp's results, and we again see that active hyperæmia accelerates absorption, although so major an experiment as is abdominal section and displacement of the viscera in itself necessarily produces an injury of the tissues of the abdominal cavity.

At first it seemed strange to me that Klapp found that an elevated position of an extremity retarded resorption, for we know from numerous experiments that œdema disappears in such a position. In healthy extremities the retardation of resorption of sugar of milk by that method could be established without any doubt, and it will not be incorrect if we ascribe this to the lessened volume of blood produced by the high posture. We therefore see that the scientific experiment confirms our view, gained from practical experience, that arterial hyperæmia favours resorption.

On the other hand, considered from a purely theoretic standpoint, it seems reasonable to conclude that a congestion bandage during its activity diminishes resorption. These suppositions have caused us to combine congestion hyperæmia with massage, when used in non-infectious diseases for the removal of stiffened joints due to rheumatism and other causes, in the hope of producing resorption of morbid material, which the hyperæmia has softened and dissolved. (See subsequent chapter.)

Klapp has undertaken to solve the question by experiment. He, indeed, found that as long as the congestion bandage was applied absorption was considerably retarded, and increased again on removal of the bandage. The increase of resorption after removal of the bandage was so considerable that the final result of the congestion hyperæmia really meant acceleration. But it must be remembered

[1] Hildebrandt, "Die Ursachen der Heilwirkung der Laparotomie bei Bauchfelltuberkulose" (*Münch. Med. Wochenschrift*, 1898).

that Klapp applied congestion hyperæmia for only one hour after the injection of the sugar of milk, and that the total excretion was completed in three hours. We, however, apply congestion hyperæmia to diseased extremities for longer periods, and we may conclude that the final result is not an acceleration of resorption. For this reason we have added massage to the treatment in such cases.

A former assistant of mine, Ritter, demonstrated earlier the retarding effect of the congestion bandage on resorption. He injected tuberculin in tuberculous extremities which were under the influence of an intense congestion hyperæmia. He succeeded in the majority of cases in retarding for a considerable time the reaction of the tuberculin.

I must make mention here of several experiments, not entirely new, which prove the retardation of resorption by congestion hyperæmia and anæmia.

The treatment of poisoned wounds with cupping-glasses is an ancient remedy used by various nations. It was thought to act by sucking the poison from the wound. From statements by Cooper,[1] it is plainly evident that he considered important the prevention of resorption of poison by means of hyperæmia produced by the cupping-glass. He mentions this in discussing Barry's experiments. The latter has successfully treated animals experimentally bitten by vipers with cupping-glasses.

We find important investigations on the influence of resorption by congestion hyperæmia and anæmia in Braun's excellent contributions on local anæsthesia.

Braun[2] showed that even an intense congestion hyperæmia considerably retards the resorption of cocaine, injected peripherally from the constricting bandage. This was principally achieved by the addition of adrenalin, this preparation producing intense anæmia.

These facts have become so well known from Braun's[3]

[1] Cooper, "Theoretic Practical Lectures on Surgery," vol. iii., p. 814. Translated by Schütte, Cassel, 1846.

[2] Braun, "Experimentelle Untersuchungen und Erfahrungen über Leitungsanästhesie" (*Archiv f. Klin. Chirurgie*, vol. lxxi., No. 1, p. 10); and "Die Lokalanästhesie, ihre wissenschaftliche Grundlagen und praktische Anwendung," Leipsic, 1905, p. 177.

[3] Compare his comprehensive work just mentioned—"Die Lokalanästhesie," etc.

methods of local anæsthesia that mere reference to them suffices.

By careful experiments on animals, Klapp[1] was able to confirm the correctness of Braun's theories that adrenalin considerably retards the resorption of cocaine.

We can therefore see that it is principally the anæmia, and with it also the congestion hyperæmia, which greatly retard resorption. For our purposes this seems of significance, because we can hope to keep back dangerous bacterial toxins in the diseased bodily part, and thus protect against them higher organs—*e.g.*, the central nervous system—because they enter the circulation slowly and can be gradually eliminated. Doubtless any artificial anæmia is but a transient condition, necessarily followed by a hyperæmia; and we, too, do not apply congestion hyperæmia continuously, but with interruptions. Theoretically considered, there appears to be the danger that, on releasing the means inhibiting resorption, the accumulated toxins will suddenly enter the circulation, and then produce grave general intoxication. This would be the case if the living tissues did not know—in a manner as yet unexplained—how to destroy organic toxic substances and to make them harmless, as more recent important contributions seem to show them able to do.

Czylharz and Donath[2] contributed, in the year 1900, the following experiment, which they have frequently employed with the same success, and which created considerable sensation: They produced in the hind-leg of a guinea-pig v. Esmarch's artificial bloodlessness, and injected into the extremity, removed from the circulation, a dose of strychnine, which readily killed large control animals in two to five minutes. All animals remained perfectly well if the constricting bandage was removed in one to four hours. The poison, therefore, must have been agglutinized or neutralized in some manner by the living tissue.

The results and conclusions of these two physicians have been disputed by Meltzer and Langmann.[3] They could only

[1] Klapp, "Experimentelle Beiträge zur Kenntnis der Wirkung der Nebennierenpräparate" (*Deutsche Zeitschrift f. Chirurgie*, vol. lxxi.).

[2] Czylharz and Donath, "Ein Beitrag zur Lehre von der Entgiftung" (*Centralblatt f. Innere Med.*, 1900, No. 13).

[3] Meltzer and Langmann, "Wird Strychnin durch lebendes tierisches Gewebe entgiftet?" (*Centralblatt f. Innere Med.*, 1900, No. 37).

confirm the experiment so far, that in the same experimental arrangement the resorption of poisons, injected into "bloodless" extremities, is somewhat hampered after releasing the constricting bandage, but by no means essentially influenced or inhibited. Meltzer and Langmann therefore deny the agglutination (binding) or neutralization of the poisons by the tissues, and explain the hampering of their resorption by the displacement of blood and lymph vessels, which is said to be caused by the constriction. This may be adapted for snake poison, which may produce grave stases, hæmorrhages, thrombosis, and even gangrene of the bitten extremity, but certainly not to poisons, which do not produce such violent reactions. For we know that a bloodlessness of one to four hours leads to a hyperæmia of the previously constricted extremities, with enormous acceleration in the circulation, and, therefore, also resorption. One would, on the contrary, anticipate that after removal of the bandage poisoning would occur more rapidly and suddenly. That this is not so appears with great clearness, owing to the accuracy of Czylharz and Donath's assertions about "detoxication."

Kohlhardt[1] was also unable to demonstrate this "detoxication" of strychnine in the tissues of rabbits made bloodless, but he succeeded in this with cocaine. He injected into constricted extremities of rabbits positively lethal doses of muriate of cocaine, and noted that the poisoning after loosening of the rubber tubing depended on the length of time of the constriction. If the tubing remained longer than one hour, phenomena of intoxication did not appear at all.

Kleine[2] confirmed the observations of Czylharz and Donath, but explained them differently. He assumes that in spite of the constriction small quantities of the poison enter the circulation by resorption or osmosis. That this is really so he proved by injecting into the constricted extremity potassium ferrocyanide instead of strychnine, and obtaining in the urine, taken from the bladder two hours later, a plain Berlin-blue reaction by the addition of muriatic acid and iron chloride. All tissues of the thigh above the

[1] Kohlhardt, "Ueber Entgiftung des Cocains im Tierkörper" (Transactions of the Deutsche Ges. f. Chir., 1901, vol. ii., p. 644).

[2] Kleine, "Ueber Entgiftung im Tierkörper" (*Zeitschr. f. Hygiene und Infektionskrankh.*, vol. xxxvi., p. 1, 1901).

constriction gave the same reaction, of course feebly. Kleine's experiments are free from objection, provided the constriction was really complete, and if he did not produce an induced hyperæmia before the complete constriction by slowly constricting the bandage. For I have shown[1] that in such extremities the congested blood returns to a great extent through the bone, which naturally cannot be constricted.

Undoubtedly Kleine's explanation of Kohlhardt's experiments is in no instance sufficient. For the quantities of poison which can pass the constriction are very small, and Kohlhardt has injected such enormous quantities of cocaine into his animals that death, or at least grave phenomena of poisoning, should have occurred if "detoxication" had not really taken place. Taken all in all, it seems to me conclusive from these experiments that in reality the living tissues, in an as yet unknown life process, may achieve annihilation of intruded poison. We shall thus understand the efficacy of the ancient remedy of constricting extremities having poisoned wounds, principally snake-bites. Certainly the constriction was usually followed by cauterization, excision or suction of the wound, but a beneficial influence was ascribed to the constriction alone, and that justifiably, as appears from the cited investigations.

For our purpose, the fact that the congestion hyperæmia here acts similarly to anæmia is of greater importance. Surely in this treatment the attenuation of the poisons by the developing œdema is important, for we know from pharmacology and from Schleich's investigations that the degree of toxic effect is to the greatest extent dependent on the concentration of the poison.

Joseph[2] has recently produced the experimental proof that poisons injected into œdematous extremities become considerably weakened in their effect. Six or seven animals, in whom he injected positively lethal doses of strychnine, escaped with their lives when the injection was made in extremities which had been rendered decidedly œdematous by a congestion bandage. That here the simple attenuation

[1] Bier, *Virchow's Archiv*, vol. cliii., p. 311 *et seq.*

[2] Joseph, "Einige Wirkungen des natürlichen Ödems u. d. künstl. Ödematisierung. Ein Beitrag zur Stauungstherapie" (*Münch. Med. Wochenschrift*, 1905, No. 40).

and correspondingly retarded resorption saved the animals, and not a specific effect of the blood-transudate, is evident from the fact that a previous œdematization with physiological salt solution had the same effect.

In this way is explained, as I have repeatedly emphasized, the striking and immediate influence of congestion hyperæmia on the course of the fever in some acute infections. We have occasionally observed a drop in the bodily temperature after the application of the congestion bandage, and a rise after its removal. Naturally, the congestion hyperæmia influences also the temperature course by annihilating the cause of the disease. Lexer[1] considers congestion hyperæmia in acute infections as full of risk, because it loosens the bacteria in large numbers, liberates their endotoxins, which enter the circulation in large quantities after release of the bandage. Afterwards I shall take up these and other objections of Lexer's.

We now understand the aim of Nature when it produces the most magnificent blood-stasis in extremities which have been bitten by snakes. This blood-stasis may increase to gangrene. Nature wants to prevent the poison from entering the circulation and being fatal, and is not afraid to sacrifice, if need be, the extremity in order to preserve life.

I have repeatedly called attention to the fact that water, and substances soluble in water normally, are almost entirely absorbed through the blood, but that this does not mean that the lymph-current could not do this ; in fact, the latter seems to be the case—for instance, in Volkmann's treatment of chronic articular effusion with powerful compression bandages. Volkmann himself describes how the bandages were so forcibly wound over the swollen joint that the part of the extremity below it became œdematous and blue. The process is for this reason so painful that the patient does not sleep during the first night, and frequently also during the second. Inasmuch as so firm a pressure renders anæmic the entire region of the affected joint corresponding to the width of the bandage, it is probable that the effusion is forced into the lymph-spaces of the joint, and carried off by the lymph-channels.

[1] Lexer, "Die Behandlung akuter Entzündungen mittelst Stauungshyperämie" (*Münch. Med. Wochenschrift*, 1906, No. 14).

On the other hand, it seems that the lymph-channels can be replaced by the blood-channels in the absorption and removal of excreted lymph. For we surgeons often extensively destroy the large lymph-trunks when cleaning out diseased axillary and inguinal glands, because we remove from the region all glands and connective tissue, leaving only the larger bloodvessels and nerves. After such extensive operations we see comparatively seldom lymph-stasis, and we must assume that the excreted lymph is taken up by the bloodvessels until sufficient collateral lymph-channels have formed. Where this does not occur, it seems that the bloodvessels have been unable to deal with the excreted lymph, for a number of cases are known in which, after such operations, lasting œdema and elephantiasis have developed.

SOLVENT EFFECT OF HYPERÆMIA

In the diseases in which experience has shown the agents producing hyperæmia to be useful, we have not always to deal with aqueous substances or such as are soluble in water, but generally with solid substances, such as blood-clots, granulations in joints, and stiff joints. If we want to cause their resorption, they must first be dissolved, and there can be no doubt that the hyperæmia is able to accomplish this. Under its influence we occasionally observe the disappearance of arthritic granulations and nodules in tendons in a comparatively short while. Among others, I had the opportunity of nicely observing it in a man whose diverse joints and tendon sheaths were in a hopeless condition due to an attack of gonorrhœal rheumatism which he had some time ago. He had been treated for a long time without any success with all sorts of mild remedies (massage, water, iodine application), and with energetic, torturing methods (medico-mechanic machines, *brisement forcé* with and without anæsthesia), but never with agents producing intense hyperæmia. On the extensor tendons of his fingers remained nodules perceptible to sight and touch, which enabled us to become thoroughly convinced in regard to the solvent effect of hyperæmia. In order to study both kinds, I first applied on one side congestion hyperæmia, then

hot air on the other. During the application of each form I could observe how the nodules shrunk and disappeared. In a similar manner I saw some years ago how a nodule in a joint, perceptible to sight and touch, disappeared under the influence of the suction apparatus. The most striking effect of the hyperæmia could be noticed in the first few applications ; later the solution proceeded less rapidly.

Recently I observed another case of solution of a tendon nodule, which had led to trigger-finger. The patient, an elderly gentleman, consulted me for the latter. I proposed the operative removal of the plainly palpable nodule, and advised him against the use of a hot-air apparatus which he wished me to prescribe for him. He purchased on his own responsibility the apparatus, and used it one hour daily. After a few weeks he presented himself, and stated that the " jerking " of the finger had soon ceased, and that the nodule had gradually disappeared. I had to confirm the correctness of the assertion.

A colleague, well known to me, Dr. Thomas of Cologne, told me that he had observed the disappearance of keloids under congestion hyperæmia. I can confirm Thomas's observations, and I will describe them later on.

As far as the fact of the solution of morbid solid substances by hyperæmia is concerned, there can be no doubt about it after these observations. I remind my readers that for ages the so-called skin irritants and " derivative " agents, or, as we assert, also agents for the production of hyperæmia, have been utilized for the purpose of solution. For this reason they have also fittingly been called softening and dividing remedies.

It is undisputed that inflammation, and especially suppurative inflammation, has a tissue solvent and melting effect. This remarkable process, on account of its similarity to digestion, has been termed " autodigestion," and more recently " autolysis," which is said to develop from the effect of a ferment, principally ascribed to the leucocytes.

The uniform effects of pure hyperæmia above described, however, plainly indicate that the inflammatory hyperæmia, too, plays a rôle. The following experience seems to confirm this : No one will think of attributing the dilatation of the urethral strictures with sounds to their mechanical

effect only. It is generally admitted that the inflammation produced by the irritation of the scar softens the latter and makes it more yielding, and, following our views now prevailing, this is accomplished solely by the pus-corpuscles. In contrast to this, I may point to the fact that scars (strictures) of the vagina, which if left unchanged would prove an obstacle to delivery, during pregnancy become so soft that they aquire an elasticity enabling birth to take place without difficulty. Here there can be no question of suppuration, and only the intense hyperæmia which prevails in all parts of the genital apparatus during pregnancy can have produced the solvent effect.

An experience of internal medicine proves that other components of blood than the leucocytes, and their products of disintegration, too, have a dissolving and melting effect. In pronounced hydrops due to diseases of the kidneys and heart, when internal remedies fail, the œdema is permitted to escape through small punctures in the leg. For days the alkaline liquid oozes from them, and macerates and dissolves the skin, unless it has been carefully protected by ointments or plasters. Yet we have here to deal with a thin blood-serum in which there can be no question of an inflammatory product.

Even Billroth,[1] in his treatise on inflammation, ascribes its solvent effect principally to the immigrated leucocytes. He says :

"Every physician knows that the firm connective tissue, infiltrated by inflammation, may totally disappear and become dissolved in the process of suppuration. It is furthermore known that even cartilage and bone in inflammation may become changed into soluble substances, and that tendons, nails and hairs only energetically resist this process of dissolution, the former being expelled as necrotic shreds during suppuration."

He demonstrates on specimens of inflamed prepuces how the inflammatory œdema and immigrated cells totally dissolve the connective tissue. He ascribes this effect to the cells, for he says : "It seems to follow from the observations quoted that one of the effects of living cells is their ability under certain conditions to transform the fibres of connective tissue, and also the fibrin fibres, into a soft, semi-gelatinous consistence."

[1] Billroth, "Mancherlei über d. Morphol. Vorgänge bei d. Entzündung" (*Med. Jahrbücher*, vol. xviii., p. 18, 1869).

We saw from the unobjectionable observations above mentioned that a solution of connective tissue is possible by hyperæmia alone. We, therefore, are forced to assert that the view that the suppurative process in inflammation only accomplishes the solution is one-sided, and we must ascribe an important rôle to the hyperæmia accompanying the inflammation during its course. I do not mean thereby to doubt the solvent and digestive effect of suppuration established by numerous observations. This effect has been ascribed for a long time to a digestive property of the pus-corpuscles; these are said to excrete so-called digestive enzymes, which accomplish the melting. It was principally Leber[1] who aided this view to victory by his beautiful and convincing experiments. But numerous other experiments, which we cannot cite here, have positively established the digestive and solvent effect of the leucocytes.

Recently Buchner[2] has ascribed to all cells of the body, in addition to constructive (assimilating), deconstructive (disassimilating) substances. The latter are said to be given by the cells as solvent digestive juices (enzymes) to the blood-serum, which assumes the same effect, while the constructive substances remain in the cells. According to Buchner, these digestive juices dissolve everything foreign that has entered the body—that is to say, not only organic foreign bodies, catgut threads, necrosed tissue, but also bacteria.

He holds to his view of the bactericidal property of the blood-serum, the effective components of which come from the leucocytes, but does not believe that this is a specific activity, but that the effect of the blood-serum, as regards the dissolution of everything foreign, embraces also the bacteria, thus causing their destruction.

Buchner represents views which Landois[3] long ago has expressed, though not so extensively. This author first showed that every species has a blood of its own, which it tries to keep clean from foreign components under any and all circumstances. For this reason any kind of foreign blood which is added to that of an animal or man is at once

[1] Leber, "Die Entstehung der Entzündung," Leipsic, 1891.

[2] Buchner, "Natürliche Schutzeinrichtungen des Organismus und deren Beeinflussung zum Zweck der Abwehr von Infektionsprozessen" (*Münch. Med. Wochenschrift*, Nos. 39 and 40, 1899).

[3] Landois, "Die Transfusion des Blutes," Leipsic, 1875.

destroyed by the blood of the receiver. Landois demonstrated convincingly that the blood-serum of every animal causes dissolution of the blood-corpuscles from any different species. Recent bacteriological research, which ignores these investigations, has fully confirmed these observations, and more extensively utilized them in an entirely new direction.

The improvement of stiffened joints which follows after the application of either active or passive hyperæmia must first of all be ascribed to the solvent properties of the blood. Certainly a good many other things must be taken into consideration. In all probability connective-tissue adhesions become softer, more pliable and elastic, in consequence of serous saturation and swelling. I have already repeatedly shown that to a great extent the removal of stiff joint is due to the relief of pain by the hyperæmia. For otherwise it were not imaginable how a man could move his joint, afflicted with chronic rheumatism, after an hour's treatment in the hot-air apparatus, or a gonorrhœic his furiously painful, completely immovable inflamed joint, after an hour's application of congestion hyperæmia.

Of late Sudeck[1] has tried to explain the favourable effect of congestion hyperæmia on joints stiffened by trauma by an improvement in the nutrition of the bone, which he has demonstrated to be atrophic. (For details see below.) It is possible, though not proven, that this, too, plays a rôle; but we cannot overlook the dissolving effect of the blood, which is proved by the disappearance of the tendon and articular nodules above described and directly observed by us.

We must never forget that the name "hyperæmia" covers a large series of chemical and physical processes, and the greater the experience which I am gaining in this direction, the more do I turn from the one-sided views here represented by Sudeck, and, as already mentioned, in a somewhat different direction also by bacteriologists. For that matter, I cannot agree to the theory, so prevalent in modern path-

[1] Sudeck, "Ueber die akute (reflektorische) Knochenatrophie nach Entzündungen und Verletzungen an den Extremitäten und ihre klinischen Erscheinungen" (*Fortschritte auf dem Gebiete der Röntgenstrahlen*, vol. v.).

ology, which ascribes the sole efficiency to only one of the many properties or substances of life processes. For if we look carefully upon the physiological processes in the body, we notice that they have a multitude of purposes which point to one final purpose. For this many examples can be cited; since we are here interested in the effect of hyperæmia, I will choose two forms of physiological hyperæmia as examples, though more striking proofs can be found in other departments.

If we subject a part of the body to intensely hot air, it becomes vigorously hyperæmic, and if the part were large other parts of the body experience the same change. This hyperæmia serves different purposes. It must give off the material for perspiration and cool the intense and rapidly flowing blood-current traversing the endangered part, and finally reduce the temperature in the entire body as the blood is led towards the peripheral parts, there giving off the warmth which it has taken up. The hyperæmia, therefore, fulfils at least three different missions: viz., it took up warmth at one place, gave it off at another, and made possible the pronounced perspiration; but all these, again, served one ultimate end—to protect the body against local and general overheating. Intense hyperæmia makes possible the excretion of water after consumption of a good quantity of food, the separation of variable digestive juices in the gastro-intestinal canal, and finally resorption. And all these various processes, again, have but one general aim—the assimilation of food.

Nothing can account better for the entirely different effect of artificial hyperæmia on diseases than this idea. One of the recognized effects of congestion hyperæmia is the formation of new bone. For this reason it is used to knit fractures of bones which do not want to heal. This very hyperæmia, nevertheless, does not permit the ends of joints suffering from large ulcers and caries to become ankylosed, but, as numerous observations have convinced me, keeps the joint mobile which otherwise would certainly have become locked. Both active and passive hyperæmia act equally in the dissolution of stiff joint. More details will be given in the allotted chapter in the special part.

Probably the solvent process of hyperæmia changes the

greater part of the diseased granulations and adhesions of stiffened joints into substances soluble in water, which are absorbed by the blood. But it can scarcely be doubted that there still remain tissue particles which are carried off by the lymph-channels. It is therefore desirable that our knowledge about the influence of hyperæmia on the lymph-current become more thorough than the representations made by me in the relative chapter. As long as we know so little about these conditions, it is useless to establish assertions and assumptions that in this direction, too, our practical experience is supported and explained by scientific recognitions.

Recently some observers have endeavoured to ascribe the effect of certain chemic and physical remedies to autolysis. Heile[1] believes that iodoform injected into cold tuberculous abscesses causes an immigration of leucocytes, whose disintegration liberates enzymes, which dissolve the contents of the abscess and render it capable of resorption.

Heineke[2] found that the application of Röntgen rays to animals destroys in the most wonderful manner the lymphoid tissues of the body, the follicles of the spleen, the lymph-glands, the intestinal canal, and in young animals also the thymus. Recently he demonstrated the same thing for the white cells of the bone-marrow. These extremely important discoveries throw an entirely new light on the puzzling effect of the Röntgen rays on animal bodies, and promise to become the basis of further important investigations. Heile concludes from Heineke's observations that the Röntgen light, too, liberates enzymes by the destruction of organic cells, which lead to the melting and resorption of normal and morbid tissues.

Perhaps Moser's[3] success with the treatment of stiff joints by radiation with Röntgen light can be explained in this manner. It is easily imagined that thereby enzymes are

[1] Heile, "Über intravitale Beeinflussung autolytischer Vorgänge im Körper" (*Zeitschr. f. Klin. Med.*, vol. lv.).

[2] Heineke, "Experim. Untersuchungen über d. Einwirkung d. Röntgenstrahlen auf innere Organe" (*Mitteil. aus d. Grenzgeb. d. Med. u. Chir.*, vol. xiv., Nos. 1 and 2, 1904); and "Über die Einwirkungen der Röntgenstrahlen auf innere Organe" (*Münch. Med. Wochenschrift*, 1904, No. 18).

[3] Moser, "Beh. v. Gelenkfrakturen mit Röntgenbestrahlung" (*Centralblatt f. Chir.*, 1904, No. 23); and "Ueber Behandl. v. Gelenksteifigkeiten mit Röntgenbestrahlung," Naturforscher Versammlung, 1904.

liberated, which dissolve the granulations and connective-tissue contractions in a similar manner as described above for hyperæmia.

Heile[1] made further contributions on the autolysis after Röntgen radiation at the Congress of Surgeons in 1905. He starts with the idea of liberating the enzymes which are accumulated in the leucocytes, and of making use of them for the dissolution and removal of pathologic conditions during life. Heile drew the leucocytes to the skin by leucotactic remedies, and rayed this place, which was followed by a Röntgen ulcer. The latter did not appear after the same radiation in the control animal, even though the tissue has been damaged by non-leucotactic remedies.

Heile healed artificially produced peritonitis in a rabbit by concentrating the leucocytes on the peritoneum of the animal and causing their decomposition with the Röntgen rays; while control animals, in spite of the same leucocytosis and with the same intense infection of the peritoneum, perished from peritonitis, as here the enzymes remained attached to the leucocytes and could not affect the bacteria.

Heile also ascribes the healing effect of congestion hyperæmia to the liberation of intracellular enzymes and their effect on pathologic conditions. According to his investigations, the application of a congestion bandage to all four extremities was followed by a pronounced disintegration of cells, which he could demonstrate by the increase of the total excretion of nitrogen and by the increased elimination of uric acid and purin bases in the urine. These experiments certainly are very important and interesting; but they, too, in my opinion, only show one side of a complicated physiologic process. For this reason I do not think they can explain the effect of congestion hyperæmia, and much less that they will restrict the use of the simple, convenient, and harmless hyperæmizing methods. I believe it proper to imitate a natural process as much as possible in all its details.

[1] Heile, "Die Autolyse als Heilfaktor in der Chirurgie" (*Archiv f. Klin. Chirurgie*, vol. lxxvii., No. 4, 1905).

NUTRITIVE EFFECT OF HYPERÆMIA

In the discussion in the preceding chapters we were in the pleasing situation of treating matters of every-day experience. As for myself, I have not the least doubt that arterial and venous hyperæmia relieve pain; that both are solvents: that arterial hyperæmia absorbs, and that passive hyperæmia cures, infectious diseases; for I have seen this with my own eyes innumerable times. I could have described each of these facts with a few words, they requiring no further proof. Nevertheless, I brought lengthy discussions in order to explain those effects from the standpoint of the scientific views of to-day, and to bring them into harmony with foreign observations. Fortunately, it was possible to accomplish the latter. Those facts, however, have been so positively established that, were the opposite the case, I still would have adhered to them to the fullest extent. I expressed myself decidedly already in the first edition of this book, though my observations then had received but little confirmation (if any) from others. For the properties of artificial hyperæmia claimed by me in the preceding chapters are so striking that I should be a poor observer indeed had I been mistaken in them.

Conditions are entirely different in this chapter, which treats on the influence on nutrition by hyperæmia. For although, in the discussion of the effect of hyperæmia, this question has been thoroughly and frequently considered in a manner directly opposite to my more recent observations, conditions are by no means clear. We will see that here the views are very contradictory.

The assertion that hyperæmia, as such, has a nutritive effect is very old. First of all, this has been claimed for the so-called functional hypertrophy. It was believed that the increased function produces hyperæmia, and this in turn hypertrophy. I do not want to enter into this old quarrel. On the whole it must be considered as decided that hyperæmia is necessary for hypertrophy, but that it is not the essential cause; but that the so-called functional irritation—a word for an as yet unknown conception—causes and enables the cells to take up substances from the excessive

nutrition offered by the hyperæmia, which they utilize for their increase or diminution. Inasmuch as we always have in view the practical aim to cure diseases with the hyperæmia, we will limit ourselves to the question: Can we succeed in passively feeding through hyperæmia weak, withered, and undeveloped parts of the body to such an extent that they increase their utility and circumference, this being the desired achievement?

In my opinion two things must here be kept strictly separated, viz.:

1. Can we bring our completed bodily tissues to a state of hypernutrition through hyperæmia? Can we, as it were, artificially fatten them, and can we by this means influence the physiologic growth?

2. Can we accelerate or incite the regeneration of tissue by hyperæmia?

Influence of Hyperæmia on the Nutrition of Completed Parts of the Body and on Physiologic Growth.

Many of the older observations on the causes and existence of hypertrophic bodily parts cannot be utilized because all possible things have been designated by the one term "giant-growth," of which we now know that they owe their origin to diverse ætiologic factors. Thus, for instance, diseases which we now would classify as syringomyelia, acromegaly, and the first degrees of diverse forms of muscular atrophy, have been regarded as pure hypertrophy of bodily parts. We shall therefore have to be careful in the selection of cases, accepting only those in which certain, or at least quite likely, hyperæmia was the real cause of the hypertrophy of tissues and bodily parts. It has been asserted that muscular hypertrophy has been observed after venous hyperæmia, especially as a consequence of venous thrombosis. Though these cases frequently have been confused with muscular affections of a different character—namely, with pseudo-hypertrophy of the muscles (lipomatous hypertrophy of muscles, juvenile progressive muscular atrophy, and muscular affections of spinal origin)—yet there are several evidently pure cases in which nothing else but a

venous thrombosis could be demonstrated as the cause of the muscular hypertrophy. The fact that the affection was limited to the domain of venous hyperæmia proves that this was indeed the sole cause. The individual cases so closely resemble each other, and are of such decisive importance to our question, that we will consider them in detail.

Paget[1] reports a case of hypertrophy of one arm after venous thrombosis. The affected arm was almost one-third larger than the healthy one, and this was principally due to a greater development of the muscles rather than to a deep œdema. The adjoining shoulder and the upper part of the pectoralis major muscle were strikingly large and wide. In connection with this case Paget mentions an observation made by Professor Laurie on himself. This gentleman became afflicted with venous thrombosis of one leg as a sequela to typhoid fever, which produced œdema and thickening of the muscles for the rest of his life.

The following cases have been observed and described in detail. The age of the patients at the time of the attack of venous thrombosis was nineteen, twenty, twenty-two, twenty-six, twenty-six, twenty-nine, and forty-one years; most of them were several years older when the hypertrophy was observed. Berger[2] reports three cases which concern the leg.

Case 1.—The affection developed from venous thrombosis during typhoid fever. The left leg was very much thickened; the contour of the quadriceps, glutei and triceps suræ muscles were considerably arched forward. The foot was in the position of tip-foot. The skin of the affected limb was traversed by numerous dilated superficial veins; the surface temperature of both extremities was alike. The thickened muscles felt firm, hard, and tense. Skin and bones were not noticeably thickened. There was no œdema. Sensibility and reflex irritability were greatly diminished throughout the entire leg. The patient easily tired in the affected limb; its strength was greatly diminished. Muscular twitching frequently occurred after exercise. Electrical irritability was greatly diminished.

[1] Cited in *Schmidt's Jahrbücher*, vol. cxxxiv., 1864.

[2] Berger, "Zur Aetiologie und Pathologie der sogenannten Muskelhypertrophie" (*Deutsches Archiv f. Klin. Medizin*, vol. ix., p. 363).

Berger took particles from symmetric places of the soleus muscle of each leg by means of Middeldorpf's harpoon for microscopic examination. There was a decided difference on macroscopic inspection. The muscle of the affected limb was pale and anæmic ; that of the healthy one had the normal deep red colour. Microscopically, a true hypertrophy of the diseased muscle was established, the fibres being more than double the normal size. Otherwise they were of normal character. There was no trace of interstitial fat or connective-tissue granulation.

Case 2.—Here, too, the disease was due to venous thrombosis following typhoid fever, and affected the left leg. The patient complained of pains, muscular twitchings, and weakness in the diseased limb. This had " truly Herculean muscles," which enlarged it considerably, while the skin could scarcely be designated as hypertrophic ; the bone was normal. Only on the dorsal side of the foot was œdema, otherwise the enlargement was due to the muscular swelling. The limb was very weak ; muscular force, electrical irritability, and sensibility, were greatly diminished.

Examination of particles of muscle from symmetrical places of both limbs removed in a manner described in the former case gave the same result as in Case 1.

Case 3.—The disease was due to a gunshot wound of the thigh, which, according to the history of the case, probably was followed by venous thrombosis. There was enlargement of the left calf, which was due to the muscles, as the skin and bones were not swollen. Nowhere was œdema to be observed ; the venous net of the calf was moderately dilated. The rest of the examination showed a condition like that of the two former cases. An anatomical examination of muscular particles was not made.

Lesage[1] tells of a man who suffered from thrombosis of the left femoral vein during an attack of typhoid fever. Lesage saw the patient two years after this event, and noted the following : The entire left leg was much larger than the right one. The hypertrophy was limited to the muscles, and was largest in the calf. Œdema and varicosities were absent. Bones and skin were not thickened. Electrical

[1] Lesage, " Note sur une forme de Myopathie hypertrophique secondaire à la fièvre typhoïde " (*Revue de Médecine*, vol. viii., p. 903, 1888)

irritability, reflexes, and sensibility, were normal; the surface temperature of the affected limb was raised.

At the end of the day some œdema appeared at the foot and malleoli, and a slight bluish discoloration of the skin. The muscular force of the diseased leg was stronger than that of the healthy one, the former, nevertheless, tiring much sooner when muscular spasms appeared in it. The muscles of the diseased limb were softer. Two years later Lesage found the same condition, the disease therefore remaining stationary.

The case reported by Eulenburg[1] concerns a man who also suffered from thrombosis of the left femoral vein in connection with a grave septic affection. A year before he had sustained a fracture of the vertebræ, which was followed by decided disturbances of innervation. Following the thrombosis was an immense hypertrophy and weakness of the muscles of the left leg. The examination of particles of muscle taken from symmetrical places of both legs showed muscular degeneration on both sides (the right leg was atrophic owing to the disturbance of innervation accompanying the fracture of the vertebræ), but on the left side "the degenerated fibres were much more numerous and thicker. They appeared swollen, though the dissection was alike. The fatty and waxy degeneration is pronounced: there are also fewer normal fibres. The interstitial fat infiltration shows characteristic series as found in pseudo-hypertrophy of muscles."

Goldscheider[2] attended a young man with hypertrophy of one leg due to thrombosis of the femoral vein accompanying a traumatic orchitis. This case was described in detail by Masskow.[3] It is of especial interest because its entire course was observed by Goldscheider. The patient was attacked by a venous thrombosis of the leg in 1894, and suffered in addition from violent twitching of the muscles. In 1897 the leg had the following appearance: The left saphenous vein and a vein on the left side of the abdominal

[1] Eulenburg, "Ein Fall von fortschreitender muskulärer Dystrophie" (*Deutsche Med. Wochenschrift*, 1885, p. 178).

[2] Goldscheider, "Verhandl. des 15. Kongresses für innere Medizin, 1897."

[3] Masskow, "Muskelhypertrophie nach Venenthrombose," Inaug. Diss., Berlin, 1897.

skin were dilated ; the leg shows some œdema and cyanosis. The muscles of the left leg, and especially of the calf, are decidedly hypertrophic, and feel harder than those of its neighbour. Its strength is weaker. The subcutaneous fat is moderately increased in the left leg. The left leg perspires more than the right, and feels warmer, but cools off sooner and has less hair. The hypertrophic limb is weaker and tires easily. Sensibility is not disturbed. Electrical irritability of the muscles of the left calf is diminished. There exist muscular contractions, which occur about three or four times per second. On exertion of the affected limb cramp-like pains develop. An anatomical examination of the hypertrophic muscles was not made.

While in all these cases the increase in volume of the extremities was positively due to a venous thrombosis, this ætiologic factor is in all probability also the cause in the two following cases, for which reason it may be permissible to add them to this group.

Auerbach,[1] in an exhaustive contribution, reports the following case : A man, twenty-four years old, noticed on undressing that his right arm was larger than the left one ; gradually weakness and rapid tiring appeared in the affected limb. Auerbach found a Herculean development of the muscles of the right arm. The skin showed extensive venous nets and a bluish marbled appearance. The right hand was cooler than the left. After a prolonged stay in the air it became dark blue.

Auerbach excised particles from the deltoid and biceps muscles of the affected limb, and from the biceps of the healthy one, for the purpose of comparison by microscopic examination. He found that the case was one of true muscular hypertrophy. This was due to a decided expansion of the muscular cylinder. They were twice as wide as found in normal muscles, but even those of the healthy arm were one-quarter wider. The muscular corpuscles were increased corresponding to the enlargement.

On operation the increased amount of blood found not only in the skin, but also in the muscle, was striking. The operation (performed in 1871) was followed by severe in-

[1] Auerbach, " Ein Fall von wahrer Muskelhypertrophie " (*Virchow's Archiv*, vol. liii., pp. 234 and 397).

flammation and suppuration in the affected limb. Auerbach demonstrated equal strength of both arms by the dynamometer; the strength of the right arm had, therefore, not increased in proportion to the muscular hypertrophy.

It is uncertain whether a venous thrombosis preceded the disease in Redlich's case, though the history of the case speaks for it to such an extent that Redlich[1] assumes this as positive. The patient, while suffering from acute fever, suddenly complained of violent pains in the left leg, which were followed by a considerable swelling. The limb remained enlarged, the patient continuing to experience abnormal sensations therein. The attending physician had diagnosed "lymphangitis." Six years later the patient was examined by Redlich, who found a considerable swelling of the left leg, especially of the calf. The enlargement was principally caused by the muscles, but the skin, too, participated in it. The bones were normal. The growth of hair was less on the affected side. The skin was marbled, but—except some varices on the left half of the scrotum—there was not noticeable any decided venous dilatation. This patient, too, complained of muscular weakness, paræsthesia, and pains, but these were not lacking also in the right leg. The patient suffered from other nervous phenomena, such as pupillary contraction, disturbances of speech, etc. Redlich considered these as incipient progressive paralysis.

A particle of muscle was excised from the calf of the hypertrophic leg for examination. During this procedure a thickened skin was found with a deep layer of subcutaneous fat. After division of the fascia there appeared a layer of fat, below which was the muscle. This looked pale, but otherwise normal. Hæmorrhage from the wound was insignificant. Redlich found generally normal muscular tissue on microscopic examination. The interstitial tissue was dense, and, like the vessels, showed cellular infiltration. Much blood-pigment was found in the corpuscles.

It is possible, yet highly improbable, that the case reported by Hitzig[2] belongs to our group. In a young man an injury

[1] Redlich, "Ueber einen Fall von Hypertrophie des linken Beins" (*Wiener Med. Wochenschrift*, 1893, pp. 1482, 1519, and 1549).

[2] Hitzig, "Ueber einen Fall von Hypertrophie eines Armes" (*Berliner Klin. Wochenschrift*, 1872, p. 588).

to the right supraclavicular fossa was followed by venous stasis and muscular hypertrophy. As there also existed paralysis of the muscles of the chest, it is very probable that this case was one of nervous trouble. Of importance is the fact, demonstrated by Hitzig, that the affected upper and fore arm was longer than the healthy one, a thing which was not noticed in any of the preceding cases.

These observations, the majority of which are unobjectionable, leave us in no doubt that as a consequence of a pronounced venous hyperæmia, as it occurs after venous thrombosis, an enlargement of the limbs takes place, which concerns exclusively or essentially the muscles. It would also seem that the proof has been established by the microscopic findings of the various investigators that we here have to deal with a true hypertrophy. This proof, however, is utterly shaken by contributions from Oppenheim and Siemerling,[1] which show that the fibres of pieces of muscle taken from living men and animals always give the impression of being hypertrophic. This is so conclusive that Oppenheim and Siemerling always can tell with the microscope whether muscles have been taken from a living being or a corpse. Zuntz expressed the opinion that living muscle strongly contracts when irritated by cutting or contusing instruments and reagents, so that the thickness of its fibres increases at the expense of length. Oppenheim and Siemerling substantiated the correctness of this explanation by experiments on animals. However, with the exception of an enlargement of the fibres, the above-mentioned observers have found no other positive sign of a true hypertrophy of muscles. Eulenburg found degenerated muscle fibres, and states expressly that there existed a fatty infiltration in the muscle, which appeared in characteristic series, as found in pseudo-hypertrophy of the muscles. Redlich found normal muscular tissue, and, on the other hand, increase of interstitial tissue characteristic of pseudo-hypertrophy.

It must be added that in all cases (except in Lesage's case, in which the diseased muscle, however, tired more rapidly) the weakness of the enlarged muscles can by no

[1] Oppenheim and Siemerling, "Ueber das Vorkommen von Hypertrophie der Primitivfasern in Muskelpartikeln, welche dem lebenden Menschen excidiert wurden", (*Centralblatt f. die Med. Wissenschaften*, 1889, pp. 705 and 737).

means be accepted as a sign of true hypertrophy. Thus Auerbach and Redlich are of the opinion that this so-called "true muscular hypertrophy" represents the first stage of the lipomatous pseudo-hypertrophy.

The conclusion which we draw from these widely discussed diseased conditions is this: There is no doubt that increase in volume of affected limbs, and especially of the muscles, may follow a venous thrombosis. Whether this is a true hypertrophy or the first stage of a degeneration of the muscular tissue proper is unknown.

For our practical purposes, however, we can draw a positive conclusion—viz., under no condition is it permissible to artificially produce hyperæmia of such intensity as to produce the so-called muscular hypertrophy. For we learn that in the majority of such cases the hyperæmia at the same time produced nervous derangements, and the result of the increase of the muscles was a decrease, and not an increase, of their usefulness.

It is possible that a true hypertrophy could be produced with a less intense congestion hyperæmia, also that intense hyperæmia after a transient hypertrophy leads to degeneration. Against this is the fact that, in many hundreds of cases which I have treated with such degrees of congestion hyperæmia used for therapeutic purposes, I have never seen muscular hypertrophy. However, I have seen that limbs attenuated from joint diseases rapidly regained their former condition, but not more so than could be explained by the improvement of the causative disease; for muscles and other tissues in many affections of the joints not only atrophy with great rapidity, but also recuperate just as rapidly if the cause be removed.

Without doubt both active and passive hyperæmia lead to rapid growth of the covering epithelial structures. Thus, it is known that in summer, when the skin is supplied with a greater quantity of blood than in winter, hair and nails grow faster. Besides, there are numerous observations which prove that the same occurs in all chronic hyperæmias. In addition decided exfoliation of the epidermis has been observed. To this class possibly belongs the so-called desquamative catarrh of congested lung, in which the alveoli of the lung are filled with masses of shed epithelia.

Every physician knows that in the vicinity of chronic ulcers, accompanied by hyperæmia, frequently increased growth of hair and epithelial thickening can be observed. Leber[1] could even artificially produce them by injecting phlogosin, a substance compounded by him producing inflammation.

From my own and Helferich's observations it can be seen that increased growth of hair very often follows passive hyperæmia ; we frequently saw the appearance of increased growth of hair after artificial congestion hyperæmia.

Recently I saw a lady whose leg had a congenital, extensive cavernous angioma, which was extraordinarily hairy.

That arterial hyperæmia has the same effect can be seen by the growth of hair in summer, and by the hairy hands of surgeons, which, as a consequence of repeated washings, are in a continuous condition of hyperæmia. It has been assumed that one or another of the chemicals employed is responsible for this ; however, all washing agents act alike in this respect, and therefore the hyperæmia remains the sole cause.

A striking example of the increased growth of an epithelial structure under the influence of hyperæmia is given by the frequently cited experiment of J. Hunter, reported by Paget :[2] If the spur of a rooster be transplanted into the hyperæmic tissue of its comb, the spur will develop to an enormous size.

It can therefore be considered as established that active and passive hyperæmia produce increased growth of cover epithelium. On the other hand, I do not know of a single case which could prove that secreting glandular epithelium is hypertrophied by hyperæmia. On the contrary, we will soon show that chronic congestion hyperæmia in the liver produces even atrophy of the epithelial cells.

I have repeatedly observed that testicles, which can scarcely be counted among the secreting glands, greatly enlarged under the influence of congestion hyperæmia, which I had employed for tuberculosis or for the dissolution of hard

[1] Leber, "Die Entstehung d. Entzündung," Leipsic, 1891, pp. 506 and 163, 164.

[2] Paget, "Lectures on Surgical Pathology."

infiltrations following gonorrhœal infection. This enlargement remained for some time after the cessation of the hyperæmia. In one case of pronounced induration of the epididymis and fistula of one testicle following gonorrhœa, I rendered both testes hyperæmic by means of a rubber tube applied at the base of the scrotum. The patient complained that at first he was tortured by intense pollutions, which occurred several times during the night, while previously he rarely had a pollution during the night. This disappeared after a temporary cessation of the application, and did not return after a shorter application of the constrictor.

As I never have been in the position to anatomically examine testes enlarged by artificial congestion hyperæmia, it must remain unanswered as to what causes the enlargement and which tissues are involved.

Moll[1] made a similar observation of increased function of a gland by hyperæmia. He endeavoured to stimulate the secretion of milk in wet-nurses who had little milk by the application to the mammary gland of a suction-bell, one hour three times daily. He reports that his first attempts have been satisfactory.

At present not much can be proved by these observations, and it remains for further observation to decide whether one is really able to stimulate and increase glandular secretion by hyperæmia.

As is known, it has been held that chronic blood-congestion in the viscera due to heart disease, emphysema, etc., produces an increase of connective tissue in them, designated as "cyanotic induration." I deem it useful to briefly review the changes which occur in the viscera in this chronic congestion hyperæmia, according to Ziegler's text-book on pathological anatomy.

The chronic engorged spleen is normally large or enlarged, rarely diminished. It is always indurated. The hardness is caused by the compactness of the red pulp. "The main change consists in an increase of connective tissue, which involves not only the trabecular system, but also the walls

[1] Moll, "Zur Tecknik der Bier'schen Hyperämie f. d. Beh. d. Mastitis nebst vorlaüfigen Bemerkungen über d. Anwend. derselben z. Anregung d. Milchsekretion" (*Wiener Klin. Wochenschrift*, 1906, No. 17).

of the bloodvessels and their vicinity. Occasionally a partial induration of the reticulum of the pulp cords can be demonstrated."

The liver in chronic hyperæmia is, as a rule, somewhat diminished, its surface sometimes uneven and granulated. On microscopic examination, the veins—especially the venulæ centrales, including the near-by capillaries—are found to be dilated. In the more intense forms of hyperæmia, all capillaries of the lobules are dilated.

"The liver cells between the dilated capillaries are always more or less atrophic, and, as a rule, also studded with yellow and brown pigment granules, some with fat globules. Degeneration has progressed farthest in the centre and in the middle zones of the acini. If the circulatory disturbances and pronounced dilatation of the capillaries has lasted for some time, a part of the liver cells may have perished, so that there remains between the wide capillaries only pigment granules. The periportal connective tissue of the liver is, as a rule, unchanged, yet it may be that it becomes hypertrophic and infiltrated by cells, so that a special kind of cirrhosis develops."

The chronically engorged kidney is hard and firm, "the connective tissue between the urinary canaliculæ is somewhat enlarged, the bloodvessels are wide and gaping, the walls of the capillaries and the adventitia of the veins thickened. Occasionally there occur inflammatory cellular infiltrations." Many of the epithelia of the canaliculæ become fatty.

In chronic hyperæmia of the lung, the vessels of this organ, especially the capillaries, are much dilated, protruding into the alveoli. The lung becomes hard. "In some spaces the connective tissue is dense or in process of inflammation or granulation, but this is due less to the hyperæmia than to repeated hæmorrhages found in such lungs."

As I found in the literature of the subject variable statements concerning the degree of granulation of connective tissue in engorged viscera, I asked my former colleague, P. Grawitz, of Greifswald, to give me his experience on this point. This pathologist granted my request with great cordiality, and supported his statements with instructive microscopic specimens, so that I became convinced of the correctness of his descriptions.

According to P. Grawitz, thickening and granulation of connective tissue is most intense in the engorged spleen. However, he is in doubt whether this change is solely due

to the chronic hyperæmia, or whether other causes, too, co-operate.

The engorged lung owes its density rather to the fulness of the capillaries (incision and pressure soften the lung), partially also to atelectases and filling of the alveoli with a primary exudate and detached cells, than to granulation of the connective tissue. Even in the most intense forms of chronic hyperæmia the increase in connective tissue may be absent, yet the "brown induration" of the lung is present.

If the congestion hyperæmia has persisted for some time in the liver, the capillaries of the lobules are greatly dilated, especially around the central vein. At the same time, destruction of liver cells takes place. This can be plainly recognized in fresh specimens, when treated with water, by the fact that the row of liver cells commences at a distance from the central vein. In the hyperæmic space one can observe only remnants of broken-down liver cells, without infiltration of small cells. In grave, prolonged hyperæmia, destruction of the liver cells extends over the entire lobule, and frequently reaches an enormous circumference. The final result of severe, chronic hyperæmia of the liver, according to Grawitz, is atrophy of the liver cells, without, as a rule, development of connective tissue.

The congested kidney is dense to the touch, but can be differentiated from chronic interstitial nephritis by the surface, which is smooth, without formation of scars. Connective-tissue thickening may be present or absent, even in the most developed forms of chronic stases. If it is present, it is even, and neither forms single foci nor produces infiltration of small cells. It is always without influence on the epithelial parts of the kidney.

P. Grawitz admits that chronic hyperæmia of the viscera frequently produces increase of connective tissue, but insists that this by no means happens regularly, and that in many cases of pronounced chronic hyperæmia it is entirely lacking.

It is known that lively connective-tissue granulation follows after chronic inflammations ; we know this especially from the chronic ulcer of the leg, where inflammation and intense blood-congestion go hand in hand.

We further know that chronic blood-congestion, and more frequently lymph-congestion and repeated attacks of chronic inflammation, may lead to thickening of the skin—the so-called elephantiasis.

No doubt exists in regard to the influence of passive hyperæmia on the growth of the bones, both in length and thickness. Stanley[1] and Paget[2] made the first observations in this direction, and v. Bergman[3] collected the then known material in an article, and added two new cases. These reports show that long bones become longer and thicker if inflammatory processes have taken place within. Similar observations increased rapidly, and Helferich[4] demonstrated in a large number of cases that lengthening of bone frequently follows necrosis (as a rule this is the cause of inflammation), occurring quickly after the disease has taken hold. To-day this fact is well known to every physician, and there is scarcely a surgeon who has not seen such cases in large numbers. It is therefore unnecessary to enter into details.

Even the earliest observers attributed this hypertrophy to the hyperæmia produced by the inflammation. v. Langenbeck[5] in 1869 framed his observations in the following three sentences :

1. Diseases which cause irritation and hyperæmia of bone tissue produce an increase in the length and thickness of the bone while the growth of bone lasts.

2. The increase in the length concerns first of all the affected bone, but can also be observed in a healthy bone of the same extremity.

3. The bone lengthened by this too rapid growth retains its dimensions throughout life. A decrease in length by resorption does not take place, even though its cause (the disease of the bone) has ceased to exist for a long time.

[1] Stanley, " Treatise on Diseases of the Bones," London, 1849.

[2] Paget, " Lectures on Surgical Pathology," London, 1853, vol. i.

[3] v. Bergmann, " Ueber die pathologische Längenzunahme der Knochen " (*St. Petersburger Med. Zeitschr.*, vol. xiv., p. 65, 1868).

[4] Helferich, " Ueber die nach Nekrose von der Diaphyse der langen Extremitätenknochen auftretenden Störungen im Längenwachstum derselben " (*Deutsche Zeitschrift f. Chirurgie*, vol. x., 1878, p. 324).

[5] Langenbeck, " Über krankhaftes Längenwachstum d. Röhrenknochen in s. Verwertung f. d. Chir. Praxis " (*Berliner Klin. Wochenschrift*, 1869, p. 265).

Ollier[1] found that the length of the long bones in young growing animals could be increased by all sorts of irritation of the diaphysis, by tearing, excision, and cauterization of the periosteum, by trephining of the medullary canal, or by the introduction of foreign bodies, provided the irritation was maintained sufficiently long.

In 1868 Schneider[2] reported a case, a young man seventeen years old, whose tibia and fibula became increased in length in connection with a chronic ulcer of the leg, and since then this phenomenon has been repeatedly observed in young individuals. That these ulcers led to thickening of bone, and even to ossification of the liga mentum interosseum, had been known for a long time. Schneider attributed this hypertrophy to an increase of blood produced by chronic inflammation in a young person.

These observations made it very probable that the venous hyperæmia which accompanies all inflammations is the cause of the growth in length and width of the bones. A number of cases now prove this to be a positive fact, since a pure venous hyperæmia was followed by the same result.

The following observation by Broca,[3] so often cited in literature, belongs to this class : A male, seventeen years old, suffered for two years from a constant venous hyperæmia of a leg, produced by an arterio-venous aneurism below Poupart's ligament. The thigh was increased by 2 centimetres, the leg by 1 centimetre, by the hyperæmia.

Krause[4] describes a case of numerous sac-like aneurisms of the forearm and hand, and pronounced varicose dilatation of the veins of the back of the hand and forearm, due to a bite from a dog in youth. These maintained for many years venous hyperæmia of the extremities, and led to ulcers of the fingers. Strohmeyer amputated the extremity at the upper arm. Krause established that the forearm was longer by 1½ Parisian inches.

[1] Ollier, "Traité expériment. et clin. de la Régénération des Os," Paris, 1867, vol. i.

[2] Schneider, "Ein Beitrag zur organischen Plastik behufs Heilung von Unterschenkelgeschwüren" (*Archiv f. Klin. Chir.*, vol. ix., 1868, p. 919).

[3] The original, "Des Aneurysmes," Paris, 1856, was not accessible.

[4] Krause, "Traumatische Angiektasie des linken Armes" (*Archiv f. Klin. Chirurgie*, vol. ii., 1862, p. 142).

A similar case is described by Nicoladoni.[1] In this case, too, a cirsoid aneurism and decided formation of varices led to a prolonged venous hyperæmia of the arm, which produced an increase in the length of the forearm. Israel[2] describes a leg lengthened 5 centimetres by venous hyperæmia due to a congenital angiectasis; and Hitzig[3] describes an arm, and Penzo[4] two legs, which were several centimetres longer, due to a venous stasis of unknown origin.

I myself have seen a case of muscular hypertrophy of an arm and lengthening of the upper arm by 2 centimetres in a man thirty-six years old, which appeared subsequent to a venous hyperæmia of unknown cause.

Probably the so-called drumstick fingers, consisting of an enlargement of the bone, nail, and end phalanx of the fingers, sometimes also of the toes, belong to this class. These are observed in grave affections of the heart, originating in childhood, emphysema, bronchiectasis, and phthisis pulmonalis, and in diseases producing chronic hyperæmia. Bamberger described in these affections thickening of the bones of the legs and forearms. Fischer[5] believes that he is able to prove their development by hyperæmia by the fact that in such cases he found an increase of 1° C. in the surface temperature of the palms as compared with other parts. It seems to me that this is no proof, for even normally the surface temperature is somewhat higher in the palm than elsewhere on the arm. However, it is probable that they owe their development to chronic hyperæmia, and not to the resorption of gangrenous substances from bronchiectases and cavernous spaces, as is held by Bamberger. Against the latter view is their occurrence with heart diseases, and a case, described by Fischer,[5] of a cachectic child suffering from craniotabes, which was frequently attacked by

[1] Nicoladoni, "Phlebektasie der rechten oberen Extremität" (*Archiv f. Klin. Chirurgie*, vol. xviii., p. 252).

[2] Israel, "Angiektasie im Stromgebiete der Arteria tibialis antica" (*Archiv f. Klin. Chirurgie*, vol. xxi., p. 109).

[3] Hitzig, "Ueber einen Fall von Hypertrophie eines Armes" (*Berliner Klin. Wochenschrift*, 1872, p. 588).

[4] Penzo, "Sulla Influenza dell' Iperemia passiva," etc. (*Atti del Reale Istituto di Scienze*, Lettere d'Arti, 1904-05, vol. lxiv., part ii.).

[5] H. Fischer, "Der Riesenwuchs" (*Deutsche Zeitschr. f. Chirurgie*, vol. xii., p. 43).

asphyxia, which again led to hyperæmia and drumstick fingers.

There is, therefore, no doubt that a prolonged venous hyperæmia produces hypertrophy of bones and of epithelial structures, principally hair. However, as the above-described cases of muscular hypertrophy are, to say the least, uncertain, I do not know of a single case of a bodily part or organ with active functions which has been rendered hypertrophic by venous hyperæmia; the observations which have been made in congested viscera speak rather for the contrary.

After it had been recognized that, under certain circumstances, superfluity of blood produces hypertrophy, this fact was made use of for practical purposes, with a view to stimulating the growth of parts of the body undeveloped in length and thickness, by rendering them artificially hyperæmic. Basing on a successful experiment on an animal, v. Langenbeck recommends in the above-cited contribution (in 1869) to hammer ivory pegs into the bones of shortened extremities of men (for instance, after resection of the knee-joint), and thus to produce an artificial inflammatory irritation — a proposition which later has been executed repeatedly in practice.

Ollier[1] recommended irritations of the periosteum in the middle of the diaphysis by repeated cauterization and other caustic agents, in order to increase the length of bones. He succeeded in lengthening the shortened shin-bone of a young girl 1 centimetre by the application of caustic paste.

Helferich[2] made the pure experiment of furthering the physiological growth of bone by means of artificial congestion hyperæmia. He reported the following cases, in which he observed the development of hypertrophy of diverse tissues by hyperæmia:

1. A boy had been treated for years for congenital luxation with an apparatus which produced congestion hyperæmia in

[1] Ollier, "Des moyens d'augmenter la longueur des os et d'arrêter leur accroissement; application des données expérimentales à la chirurgie" (Comptes rendues hebdomadaires des séances de l'académie des sciences, Paris, 1873).

[2] Helferich, "Ueber künstliche Vermehrung der Knochenneubildung" (*Archiv f. Klin. Chirurgie*, vol. xxxvi., p. 783, 1887).

the diseased leg. As a consequence, skin and muscles became thicker, while the bones increased in length.

2. A sixteen-year-old girl had an increase of 3 centimetres in her leg from a chronic ulcer. Helferich succeeded in lengthening the healthy extremity 2 centimetres by congestion hyperæmia. This artificial hyperæmia produced a true thickening of the skin.

3. Boy, ten years old, leg shortened $3\frac{1}{2}$ centimetres subsequent to a fracture of the femur, and lengthened $1\frac{1}{2}$ centimetres by congestion hyperæmia.

4. Girl, aged nine years, who had a slight paralysis of a leg. After the application of congestion hyperæmia for four months, there was a slight lengthening of the tibia, thickening of the skin, and increased growth of hair.

Helferich states that he has used artificial hyperæmia also in five cases of infantile paralysis, but he was not able to control the effect because of the shortness of the treatments.

Helferich's remark is indeed noteworthy, that after a prolonged application of congestion hyperæmia he observed regularly thickening of the skin without œdema—*i.e.*, true hypertrophy of the skin.

His observations concerning the favourable influence of congestion hyperæmia on the formation of callus will be discussed elsewhere. We will here discuss his attempts to improve the deficient formation of sequestra by means of congestion hyperæmia. He succeeded in improving the formation of involucrum in cases of spontaneous fracture from total necrosis. Helferich used successfully a mild congestion hyperæmia for the rapid production of an involucrum before solution of the sequestrum.

Schüller[1] repeated Helferich's experiments to treat atrophy and shortening of bone with artificial congestion hyperæmia. He, however, added massage, inunctions, and sea-baths, so that the results of his treatment are not pure. In addition he instituted a dietetic treatment consisting of good nourishment, and the introduction of calcium salts, and limitation of the consumption of lactic acid in the

[1] Schüller, "Mitteilung über die künstliche Steigerung des Knochenwachstums beim Menschen" (*Berliner Klin. Wochenschrift*, 1889, Nos. 21 and 50).

food. He experienced good results in several cases of infantile spinal paralysis which had resulted in shortening and muscular atrophy. After several months of treatment, he succeeded in not only equalizing the shortening of the bones, but also in considerably improving the muscular atrophy.

In three cases, Schüller, previous to the institution of this treatment, drove nickelled steel tacks in the bones. These were left *in situ* five to nine days, and then removed. After two weeks, hyperæmia, etc., was instituted.

The first of these cases has improved so strikingly that it merits brief quotation : A sixteen-year-old girl, who had been attacked by infantile spinal paralysis when two and a half years old, still had as a sequela a shortening of 3 centimetres of the right leg, a diminution of the right foot, decided atrophy of the calf, complete paralysis of the toes, lividity and coldness of the skin of the foot. The treatment described, which was maintained for eight months, has produced a lengthening of the leg so as to be almost even with the healthy one, enlargement of the foot, and "the calf, which before had almost entirely disappeared, has become full again." The toes now can be moved actively—that is to say, flexed and extended—while before they were never moved spontaneously. The foot, which was always blue and ice-cold, and could make no other motion save that of limited dorsal flexion, and which, when left alone, regularly tipped outwardly, now has normal colour and warmth, and can be moved actively in every direction.

It must be added that Schüller previously had performed arthrodesis of the foot and section of the plantar aponeurosis, and, in addition to the hyperæmic, gymnastic, and dietetic methods, has treated the case also orthopædically.

Of great importance also is Schüller's assertion that he has produced one-sided formation of bone tissue. In a case of pronounced genua valga due to rachitis, he drove nickelled steel nails on the outside of both femora, about two fingers' breadth above the epiphyseal line, and removed them after five days. Two weeks later the described method—hyperæmia, massage, and gymnastics—was instituted, and the child sent to the seaside. Four and a half

months later the worse deformity had entirely disappeared, the other considerably improved. Schüller attributes this difference to the fact that the steel nail was driven in deeper on the right than the left side, especially in the thighs. Both legs had grown considerably, which Schüller attributes to his treatment. Since we know that rachitic genua valga frequently disappear, after the institution of a rational hygienic therapy only (which was also done here), this case loses much of its value as proof.

While the observations concerning the influence of passive hyperæmia on hypertrophy are numerous, they are limited in regard to active hyperæmia. I have already mentioned that the latter produces an increase in the growth of hair.

Bidder[1] removed from a young rabbit a piece from one sympathicus 1·5 centimetres long, and thus produced arterial hyperæmia of the concerned half of the head. The ear on that side became wider and longer than that on the healthy side. The same experiment, with like success, was performed by Stirling[2] on young growing rabbits and dogs.

Penzo[3] made one of the ears of a growing rabbit lastingly hyperæmic by subjecting it throughout the greatest part of the day to a temperature of + 37° to 38° C., the other at the same time anæmic by employing a temperature of + 10° to 12° C. In five experiments he always obtained the same result : the hyperæmic ear grew much faster. According to a photograph of the head of a rabbit thus treated, the difference in size was considerable.

Here belongs also the experiment above quoted, by I. Hunter, the unusual growth of a spur of a rooster transplanted into the hyperæmic comb.

In opposition to this, Virchow[4] says that one can (probably in grown animals) maintain hyperæmia of half the head for weeks and months by cutting the sympathicus without

[1] Bidder, " Hypertrophie des Ohres nach Excision eines Stückes vom Halssympathicus des Kaninchens " (*Centralblatt f. Chirurgie*, 1874, p. 97).

[2] Stirling, " Notes on the Effect of Division of the Sympathetic Nerves of the Neck in Young Animals " (*Journal of Anatomy and Physiology*, vol. x., 1876, p. 511).

[3] Penzo, " Ueber den Einfluss der Temperatur auf die Regeneration der Zellen, mit besonderer Rücksicht auf die Heilung der Wunden " (*Moleschott's Untersuchungen zur Naturlehre*, 1893, vol. xv., pp. 117-125).

[4] Virchow, " Die Cellularpathologie," Berlin, 1858, p. 113.

producing the least change in nutrition; and Cohnheim[1] says the same, even of young, growing animals.

Even atrophy has been observed after arterial hyperæmia due to resection of nerves. Thus, Schiff has seen atrophy of the laryngeal lobe in the turkey; Legros removed the uppermost ganglion of the sympathicus of a young rooster, which was followed by atrophy of the comb on the concerned side; and Brown-Séquard and Vulpian,[2] after cutting through the sympathicus of a guinea-pig, observed atrophy of the brain on the related side.

These experiments, therefore, prove that artificial arterial hyperæmia produced by section of vaso-motor nerves, though frequently producing hypertrophy, is not necessarily always followed by this result. I have already remarked that the following everyday experiences are against arterial hyperæmia under natural conditions producing hypertrophic effects: People who expose during the greater part of the day their skin, especially that of the face, to high temperatures, thus rendering it hyperæmic—such as glass-blowers, foundrymen, stokers, bakers—by no means have a hypertrophic skin, but, on the contrary, one characterized by delicacy and paleness when away from heat.

My own hands and forearms, since I have become a surgeon, on account of the repeated washings, are in a continuous state of hyperæmia, which, to judge from the colour, is an arterial hyperæmia. The skin of these parts, however, has by no means become hypertrophic—if anything, rather atrophic.

Among hundreds of cases which I have treated with active hyperæmia by means of hot air, I have not seen a single case in which this agent has produced an increase in the nutrition of the treated part which could not be explained by the improvement of the affection proper.

With the exception of the observations by Helferich and Schüller, I have nowhere found in the literature data on experiments to accelerate physiologic growth and to remove existing atrophies by pure congestion hyperæmia. I am not aware that it has been attempted to achieve the

[1] Cohnheim, "Allgemeine Pathologie," vol. i.
[2] Cited after Roux, "Der Kampf der Teile im Organismus," Leipsic, 1881.

same purpose by active hyperæmia. This is due to the fact that whatever observations on hypertrophy subsequent to hyperæmia were accidentally made concerned almost exclusively the venous hyperæmia. To this must be added the fact that, previous to my recommendation to utilize high degrees of heat, a harmless remedy to produce active hyperæmia was unknown. It is impossible to produce paralysis of vaso-motor nerves in man. For this reason I deem it important to publish here a few observations which I made when I first began to experiment with hyperæmia, and which I published some time ago.

I tried to improve pronounced muscular atrophy and paralysis by artificial hyperæmia in three cases of spinal infantile paralysis of the lower extremities. There were no shortenings of the bones; whether the treatment produced an increase in their length I cannot tell, as I have made no examinations in this respect. I therefore must limit my description to the effect exercised by the hyperæmia on muscles and skin.

For the first two months I applied in the three cases prolonged congestion hyperæmia. The constricting bandage was changed twice daily to a different place. I can confirm Helferich's observations that the paralyzed extremities tolerated this method of treatment very well. I could not observe any result in a single case. I then applied, two to three hours daily, artificial arterial hyperæmia by means of hot air—in one case two months, in the others one month each. This also was well tolerated.[1] Certainly, I was very careful, and never permitted the heat to become excessive. Hyperæmia, nevertheless, appeared in a sufficiently intense form. In one case I had a satisfactory success in so far that the previously cold and blue limb during the treatment became warmer, while the blue colour faded. However, this success disappeared after the cessation of treatment. The arterial hyperæmia did not have the least influence on the nutrition of the skin and muscles. In one case it even seemed to me as if the atrophic skin became thinner and more sensitive.

[1] I have demonstrated on a previous occasion (*Virchow's Archiv*, vol. cliii., p. 332) that the vessels of cold, blue, paralyzed limbs very well react to agents which produce active hyperæmia, as the artificial bloodlessness normally produces in them a pronounced reactive hyperæmia.

If we review the numerous cases and observations which have been cited to show that hyperæmia, as such, produces hypertrophy, we are only certain that, as a consequence of chronic hyperæmia, bones frequently experience an increase in length and thickness, cover epithelium granulates, and connective tissue may increase, though the latter is not always the case.

As far as the muscles are concerned, it is extremely doubtful whether they become hypertrophic when influenced by chronic hyperæmia. Even if we allow that the above-mentioned cases, anatomically considered, are true hypertrophies, physiologically they must be considered degenerations, as they led to muscular weakness. Thus, artificial hyperæmia as a means of producing muscular hypertrophy in practice is out of the question, especially since the latter has been observed in such intense forms of prolonged hyperæmia as could scarcely be made use of without injuring the patient. In regard to other tissues, we know of no unobjectionable example which shows that it could be placed passively in a condition of hypertrophy by hyperæmia ; on the contrary, a few observations demonstrate that intense lasting hyperæmia may even produce atrophy. For them, therefore, Virchow's dictum holds good, that the cell cannot be nourished passively, but nourishes itself, refusing nutrition offered in excess, unless influenced at the same time by stimuli—the nature of which is as yet unknown to us—which cause it to grow and multiply.

On the other hand, we must admit that, as far as the cover epithelia and supporting tissue (bone, cartilage, connective tissue) are concerned, there exists a possibility of passive nutrition by hyperæmia, though occasionally, as is shown by the above-mentioned observations, this may not occur.

I therefore believe that Roux[1] is correct in assuming that only the organs with passive[2] functions (supporting

[1] Roux, "Der Kampf der Teile im Organismus," Leipsic, 1881.

[2] Organs functionating purely passively do not exist. Connective tissue contains the lymph-nodules, and therefore participates in the preparation of blood, and perhaps has some other "glandular" functions. Bone, whose function to sustain weight and muscle tension apparently is purely a passive one, contains the marrow, which is also active in the preparation of blood. In spite of this, the word "passive" here will scarcely be the cause of misunderstandings.

tissue and cover epithelium), but never those with active functions (muscles, nerves, secreting epithelia), are capable of increasing by mere supplemented nutrition without other stimuli. Before I knew Roux's statement, I had differentiated these things in such a way that I said: Only the simple tissues, which remain alive and exist even with the poorest nutrition, as is the case with the supporting substances and cover epithelium, can be passively nourished by hyperæmia, but not the more highly organized tissues.

That this differentiation between the diverse tissues is justified is shown by the numerous observations of the substitution of highly developed tissue by connective tissue which occurs in the disturbances of nutrition. This is especially plain in the experiments made by numerous investigators[1] in artificial circulatory disturbances in the kidney. If one ligates the renal artery, either alone or with the renal vein, the first consequence of this operation is an enormous accumulation of venous blood, so that the kidney enlarges two to three times. The accumulation occurs because the empty vascular territory of the kidney, whose artery represents "end artery" in Cohnheim's sense, is first of all filled with venous blood from the capillary anastomoses of the capsule. Later the hyperæmia decreases, and the kidney is even found to be anæmic. After about eight days it regains its former size, then shrinks more and more, and finally, if the supply of blood has been effectively interrupted, becomes a small mass of connective tissue in which not infrequently calcification occurs. The microscopic examination of such kidneys shows that during the condition of venous blood-stoppage the epithelium rapidly dies off. Even when the ligature lasts but a few hours, it cannot be saved. In its place there appears an extraordinarily rapid formation of connective tissue, which at first is rich in blood granulating into the kidney from

[1] Compare, among others, Cohn, "Klinik der embolischen Gefässkrankheiten; Talma, "Der Verschluss der Nierenarterie und seine Folgen" (*Zeitschr. f. Klin. Med.*, vol. ii., p. 483); Litten, "Ueber den Einfluss arterieller Anämie auf die Gefässwände" (*Virchow's Archiv*, vol. lxxxviii.), and "Untersuchungen über den hämorrhagischen Infarkt und über die Einwirkung arterieller Anämie auf das lebende Gewebe" (*Zeitschr. f. Klin. Med.*, vol. i., p. 131); Nicolai, "Ueber die Ligatur der Nierengefässe" (*Habilitationsschrift*, Kiel, 1895).

various sides, but finally it changes into a shrinking scar.

These experiences show us how careful we must be if we apply to all tissues observations which show hypertrophy of individual tissues by hyperæmia.

Thus, I must adhere to my already expressed view that I consider as useless the attempts to make formed and finished bodily parts hypertrophic by artificial hyperæmia. I also hardly believe that one could succeed in so regularly influencing physiologic growth with this agent that one can indicate a method with which the desired purpose can be obtained with some certainty. However, I do not doubt that, under certain circumstances, artificial lengthening of growing bones can be produced by that agent. I must hold fast to this negative view, in spite of the favourable observations made by Helferich and Schüller. Helferich's cases were few. He could increase the length of shortened, growing bones in the four cases in which he used congestion hyperæmia ; in the five cases of paralyzed extremities treated in the same manner he did not produce muscular hypertrophy. As far as the thickening of the skin is concerned, which Helferich has regularly observed after application of congestion hyperæmia, I am inclined to believe, for reasons to be stated below, that we had here to deal essentially with a chronic œdema.

Schüller's results in producing not only lengthening of bones, but also considerable hypertrophy of paralyzed muscles, are indeed very striking. But, on the one hand, his experiments are not pure, for, in addition to hyperæmia, he made use of several other therapeutic agents ; on the other hand, the case in which muscles which were completely paralyzed thirteen and a half years became thicker, and regained their function, is in so striking a contrast to all our experience concerning the restoration of paralyzed muscles that it alone can scarcely be regarded as offering any proof.

That those observations are limited to but a few cases is for me decisive. I can only repeat that among the many hundreds of cases which I have treated with congestion hyperæmia, and among the many hundreds to which I applied active hyperæmia—with the exception of increased

growth of hair and isolated limited lengthening of bone—I have never seen a case of hypertrophy of tissues due to the hyperæmia which could not be explained in the simpler way, as due to the improvement of the malady itself. I must admit that we have not paid sufficient attention to the increase of growth of bones in length, and that this perhaps occurred oftener than we have assumed. If, however, this had occurred regularly, and to a great degree, it could not have escaped us. And yet I have used treatment with hyperæmia in several cases for years.

Since writing this, I made the following observation, which at first glance seems to shatter this my opinion :

A boy, aged eleven, whose father died of phthisis, became affected in March, 1902, with a caries sicca tuberculosa of the right shoulder-joint, and entered May 13, 1902, the surgical clinic.

He was a small, lean boy, with weak muscles. The entire region of the right shoulder was very lean. This concerned especially the deltoid muscle and those of the fossa supra- and infra-spinata, so that the acromion and the spine of the scapula protruded prominently. The joint was ankylosed, the scapula participating in each attempt at motion of the joint. The sulcus intertubercularis was sensitive on pressure ; the right arm was 2½ centimetres shorter than the left one. The Röntgen picture showed considerable destruction of the head of the humerus.

Hyperæmia of the shoulder, as depicted in Fig. 9, was applied from May 15 to 29 ten to twelve hours daily ; then up to August 1 two hours daily (one hour in the morning and one hour in the afternoon). Improvement of mobility did not result. The Röntgen picture taken previous to his discharge seems to show a bony ankylosis of the joint. On the whole, the disease seems to have improved ; the general condition of the patient is better. On his discharge, August 2, 1902, the right shoulder, which previously was sunk in and atrophic, was at least as arched as the left one, if not more so. The right arm was exactly as long as the left one. On inspection, the atrophy of the muscular system seems to have disappeared. Mensuration showed that the right upper arm was still ½ centimetre thinner than the left one. The previously existing painfulness, especially that on pressure on the sulcus intertubercularis, had entirely disappeared.

This result surprised me very much. In the course of two and a half months the shortening of 2½ centimetres was remedied, and the atrophic soft parts to all appearances became as large as those on the healthy side, though the shoulder-joint could not be used on account of the ankylosis. That the lengthening took place indeed, and is not due to an error in measuring, is evident from the two Röntgen pictures taken on admission and before discharge under the same conditions. While the former shows atrophy of the epiphysis, as compared with the healthy arm, in the latter can be seen a bulky epiphysis which is broader than that of the healthy side. The same is the case with the neighbouring part of the diaphysis. To be sure, measurement with the compass (the pictures are of the same size) shows that the diseased epiphysis is about 1 centimetre lower than that of the healthy side, but, at any rate, this is equalized by its greater broadness and the increased growth of the diaphysis.

One would think that this is a pure case of passive nutrition of an atrophic joint by hyperæmia, yet I do not believe that the case is to be thus regarded, for, in addition to the disappearance of the other atrophies, that of the muscles of the fossa supra- and infra-spinata disappeared also, although they were external to the constricting rubber tubing, and not at all affected by the hyperæmia. Therefore in this case also the disappearance of the atrophy occurred in connection with the improvement of the primary disease.

I have frequently tried to nourish the entire human being in a different manner. As is well known, the body is stimulated to increased formation of blood by withdrawal of blood; the successes of venesection in chlorosis are explained in this manner. I have tried to withdraw from the circulation large quantities of blood in anæmic people by subjecting larger bodily parts to congestion hyperæmia, and thus to stimulate the rest of the body rendered bloodless towards formation of blood. To be sure, I never had pure cases, but have employed the method only when it was indicated because of a different affection. Thus, if we had an affected ankle-joint in an anæmic patient, the congestion bandage was applied high at the thigh, without bandaging the healthy part of the leg. I am under the impression—we can only talk here of impressions—that I have succeeded in several cases in improving and increasing the blood, and it may be profitable to observe this in the future.

Influence of Hyperæmia on Regeneration.

We know from the experiments by Ambroise Paré, v. Dumreicher, Nicoladoni, Helferich, and Thomas, that retarded formation of callus can be considerably increased by institution of artificial venous hyperæmia. It even seems that by means of hyperæmia the deficient stimulus to formation of bony tissue in absent formation of callus can be supplied. At this time the influence of hyperæmia on the healing of fractures was acknowledged.

I have made similar experiences in inflamed, especially in subacutely inflamed, joints. Here inflammatory foci under

congestion hyperæmia change into stone-hard connective-tissue scars. In tuberculous inflammations one can observe a hardening of the soft tuberculous granulation swelling and its change into scars, although, naturally, this takes place very slowly. Only in a few isolated cases, which we will describe, the congestion hyperæmia produces a sort of acute inflammation, and also changes the tuberculous granulation masses into tough, shrinking connective tissue with incredible rapidity. This kind of regeneration and rapid formation of completed connective tissue, in principle, is the same process, but, in my opinion, more striking and more convincing than the healing of a pseudo-arthrosis ; for we can see the entire process take place before our eyes in a few days, and by the sense of touch can follow the progress of cicatrization. This extraordinarily rapid cicatrization can be explained by the fact that the first stage of connective-tissue formation—infiltration of small cells and granulation—is already present in these inflammations.

The transformation of inflammatory foci in connective-tissue scars possibly plays a great rôle in the cure of infectious diseases. I do not think that in all cases of healing of joints affected with an infectious disease the congestion hyperæmia necessarily kills the bacteria ; this may be done by means of serum in Buchner's sense, by phagocytes in Metschnikoff's sense, by carbonic acid in Hamburger's sense, or by other as yet unknown bactericidal components of the blood, but I believe that a rapid cicatrization of inflammatory foci encapsulates the bacteria and makes them harmless. We know from experience that Nature not infrequently makes use of this method.

Naturally, the influence of hyperæmia on the formation of callus has been investigated experimentally. I will not discuss the numerous experiments by means of cutting through of mixed nerves where, in addition to the sensible and motor paralysis on account of destruction of vaso-motor fibres, there is also produced an arterial hyperæmia. I believe that these experiments have but a limited value for the decision of our question ; for, in addition to the hyperæmia, so large a number of unforeseen changes take place which influence healing, that it is difficult to say whether the hyperæmia, as such, exercises any influence on

the healing of the bone-wound or not. This is noticeable in the results of these experiments.[1] Some investigators found that cutting of the nerve furthers the formation of callus; others, that it retards the latter; and, again, others assert that it has no influence whatever on the course of the healing. For the same reason I have not considered in the first section of this chapter Nasse's[2] much-discussed contribution on the influence of nerve section on the nutrition of bone.

That these experiments cannot be used for our question is evident. Samuel[3] has given us the experimental proof that here unnatural conditions are created for regeneration. He cut the plexus axillaris of the wings of doves, and there appeared not only a pronounced hyperæmia, but also a formation of a large, steadily growing vascular net at the place of feather formation in the paralyzed wings, which lasted several months. The consequence, however, was not an increase, but a diminution, of the growth of newly forming feathers, which became more pronounced as the paralysis continued. If, on the other hand, Samuel tied the axillary artery in an otherwise healthy wing, there appeared for the time being a retardation of the growth of feathers, which, however, again increased when the collateral circulation formed.

The only contribution which can be used for our purpose is that by A. Bum[4] and R. Penzo, who instituted congestion hyperæmia in their animals in the same manner as we do in our patients. Bum investigated the effect of congestion hyperæmia on the cure of fractures. As rabbits are not convenient for experiments with congestion hyperæmia, he

[1] A summary of the views concerned will be found in the later contributions by Kapsammer: "Das Verhalten der Knochen nach Ischiadicusdurchschneidung" (*Archiv f. Klin. Chirurgie*, vol. lvi., p. 348, 1898); and Muscatello and Damascelli, "Ueber den Einfluss der Nervendurchschneidung auf die Heilung von Knochenbrüchen" (*Archiv f. Klin. Chirurgie*, vol. lviii., p. 937, 1899).

[2] Nasse, "Ueber den Einfluss der Nervendurchschneidung auf die Ernährung, insbesondere auf die Form und die Zusammensetzung der Knochen" (*Pflüger's Archiv*, vol. xxiii., p. 361, 1880).

[3] Samuel, "Das Gewebswachstum bei Störungen der Innervation" (*Virchow's Archiv*, vol. cxiii., p. 272, 1888).

[4] Bum, "Die Entwicklung des Knochencallus unter dem Einflusse der Stauung" (*Archiv f. Klin. Chirurgie*, vol. lxvii., p. 652, 1902), and "Experimentelle Untersuchungen über den Einfluss der Stauung auf die Entwicklung des Knochencallus" (*Centralblatt f. Chirurgie*, 1901, No. 47).

used young dogs, in whom he produced fractures of the diaphyses of both tibiæ. The extremities were placed in plaster-of-Paris casts around the foot and knee joints in position of extension. Commencing with the following day, daily applications of the congestion bandage lasting one and a half hours were made to the thigh of one side. After rejecting all experiments which permit of a doubtful meaning, Bum comes to the conclusion that the callus formation on the side where congestion hyperæmia had been maintained had undoubtedly progressed farther. First of all, the periosteal callus was better formed in several cases, and the medullary callus in some. Whether or not the formation of the intermediary callus was furthered by the hyperæmia could not be decided. The deposition of calcium salts in the callus seemed to be increased. On the other hand, Bum found that only when there was disposition toward good formation of callus was any noteworthy success experienced from hyperæmia.

R. Penzo[1] recently studied in rabbits the influence of congestion hyperæmia on regeneration. He comes to the following conclusion: "(1) A moderate venous hyperæmia characterized by cyanosis, œdema, and rise of temperature of the extremity, favours the physiologic processes of regeneration of cells, the increase of tissue in the animal, and the healing of all kinds of wounds. But it does not suffice alone for the reawakening of the regenerative activity of tissues, whose formed cellular elements no longer possess this regenerative activity. (2) Too pronounced hyperæmia, characterized by cyanosis, œdema, and cooling, leads to opposite results."

Penzo's experimental work offers a confirmation of my views presented long ago, and based on clinical experience.

Except Bum and Penzo, I know of but one more experimenter, Samuel,[2] who has experimentally studied the effect of hyperæmia on regeneration, especially on that of feathers. But his experiments also cannot be made use of, because he has applied high degrees of hyperæmia such as we never dare use for therapeutic purposes, and which have the

[1] R. Penzo, "Sulla influenza dell' iperemia passiva nella rigenerazione cellulare," etc. (*Atti del Reale Istituto Veneto di Scienze*, vol. lxiv., part ii., Venice, 1905).

[2] Samuel, "Gewebswachstum bei Störungen der Blutzirkulation" (*Virchow's Archiv*, vol. cviii., p. 1).

opposite effect from that used in practice. He found that a constrictor applied to the wing of doves produced a small yet plainly perceptible retardation of growth of the newly forming feathers. But he applied the constrictor so firmly that it frequently produced gangrene of the entire wing, or at best suppurating vesicles and eschar of the skin, and permitted the constrictor to remain for a prolonged time. Thus, he produced destruction of nutrition of the worst kind, and it is to be wondered that by it the growth of feathers was not more retarded.

Long ago numerous experiments have been made to investigate the influence of arterial hyperæmia on the processes of regeneration. I will omit the discussion of these experiments[1] in which, by the cutting of mixed nerves in the extremities, arterial hyperæmia is produced, in addition to all possible grave changes of the tissues. Of greater value are those experiments where, by means of cutting or resection of the sympathicus of the neck, arterial hyperæmia of one half of the head is established. The majority of experimenters have worked with this method, but have reached the most contradictory results.

Virchow[2] applied in dogs and rabbits, in whom he cut through the sympathicus on one side, inflammatory stimuli on equal places in both sides as equally intense in degree as possible, but could notice no difference in the course of the inflammations. From this and other observations, he concluded "that the larger or lesser introduction of blood to a part is not as important for the nutrition of the individual elements as has often been supposed."

On the other hand, Snellen[3] found that cutting through the sympathicus accelerates the process of inflammation, the absorption of exudates, the healing and cicatrization of wounds of the concerned half of the head.

[1] Beck, "Histologische und physiologische Untersuchungen über den Heilungsprozess der Wunden, über die Bildung und Umwandlung der Exsudate und ihrer mikroskopischen Formelemente; Untersuchungen und Studien auf dem Gebiete der Anatomie, Physiologie und Chirurgie," Karlsruhe, 1852; and Joseph, "Ueber den Einfluss der Nerven auf Ernährung und Neubildung" (*Archiv f. Anatomie, Physiologie u. Wissenschaftliche Medizin*, 1872, p. 206, experiments on frogs).

[2] Virchow, "Handbuch der speziellen Pathologie und Therapie," vol. i., p. 274, Erlangen, 1854.

[3] Snellen, "Archiv für holländische Beiträge," 1857. The original was not accessible. Cited after Samuel, *Virchow's Archiv*, vol. xxii., p. 405

O. Weber[1] confirms Snellen's experiments :

"If the same injury be inflicted at the same time on the paralyzed and on the healthy ear, the reaction on the vaso-motorically paralyzed part will be found more intense than in the healthy part. It does not matter whether the injury consisted in the introduction of a pea or glass bead in a cut wound, an incised wound, or the application of equal-sized pieces of caustic potash. Healing occurred more rapidly in the paralyzed part, as the formation of cells and vessels takes place more rapidly."

These investigations remained undisputed until, in 1871, Sinitzin's[2] contribution recalled them. From that year up to the most recent time a series of investigations have been published on this question without an understanding being reached. Sinitzin maintains that the hyperæmia following the removal of the highest sympathicus ganglion gives the operated side greater power of resistance to foreign and neutral substances. Fine glass threads which he inserted at symmetrical places of both cornea produced the most violent inflammations of conjunctiva, cornea, and iris, ulceration and threatening panophthalmia, but on the operated side there appeared either no reaction whatever or a very slight one. If shortly before or after the removal of the highest sympathicus ganglion of the neck the trigeminus was cut in the cavity of the skull, the known disturbances of nutrition, neuroparalytic keratitis, ulcers of the conjunctiva and mucous membrane of the mouth, did not appear. The disturbances of nutrition, even though far progressed, can be cured or improved when the sympathicus ganglion is afterwards removed. This occurred even when no preventive measures were undertaken for the operated side ; if, however, the carotid was ligated so that a hyperæmia could not be produced, the phenomena of disturbed nutrition became established.

The correctness of Sinitzin's results has been keenly disputed. Eckhard[3] and Senftleben[4] retested the experi-

[1] O. Weber, "Die Gewebserkrankungen im allgemeinen und ihre Rückwirkung auf den Gesamtorganismus" (Pitha-Billroth's "Handbuch d. Chirurgie," vol. i., p. 404, 1865).

[2] Sinitzin, "Zur Frage über den Einfluss des Nervus sympathicus auf das Gesichtsorgan" (*Centralblatt für die Med. Wissenschaften*, vol. ix., 1871, p. 161).

[3] Eckhard, "Bemerkungen zu dem Aufsatz des Herrn Sinitzin : Zur Frage über den Nerveneinfluss des Nervus sympathicus auf das Gesichtsorgan" (*Centralblatt f. d. Med. Wissenschaften*, vol. ii., 1873, p. 547).

[4] Senftleben, "Ueber die Ursachen und das Wesen der nach der Durchschneidung des Trigeminus auftretenden Hornhautaffektion" (*Virchow's Archiv*, vol. lxv., p. 69, 1875).

ments, and both found that the removal of the uppermost sympathicus ganglion has no influence on the establishment and course of disturbances of nutrition following cutting of the trigeminus.

Danilewski[1] produced inflammation in the ear of a rabbit, and excised pieces from it. One to two days later he cut through the sympathicus, and made the following observations :

"The reactive hyperæmia produced by croton-oil equalizes more rapidly on that side in which, owing to cutting of the nerves, there was larger discharge, the inflamed place being characterized during the first twenty-four hours by a specially intense colour. If vesicles occur, with transparent or pus-like contents, the inflammation on the neurotomized side runs a more pronounced and violent course, the accumulation of blood is greater, the granulations are more developed and hyperæmic. The course of the inflammatory process on the neurotomized side terminates twice as rapidly as that of the other. Healing on the operated side frequently takes place without loss of substance, occasionally even with hyperplastic granulation in the form of regeneration. On the opposite side the inflammation terminates, as a rule, with incomplete regeneration or more or less loss of substance. Suppuration on the neurotomized side is always more pronounced, the pus having the characteristics of the pus *bonum et laudabile*. On the unaffected side it is greyish, watery, semitransparent, and flocculent. Necrosis following violent irritation takes place exclusively on that side where the sympathicus is intact."

If Danilewski produced the inflammation only one to two days after the cutting of the sympathicus, a more intense reaction occurred on the operated side, the hyperæmia was more pronounced, suppuration appeared more freely, and granulation was stronger. Blood-effusions could be more easily produced on the operated side, but they were again more rapidly absorbed. Punched-out wounds healed twice as quickly on the operated side as on the opposite one, the regeneration of the tissues was more complete, while violent irritation led but little to necrosis.

While thus Danilewski confirmed the experiments of Snellen, O. Weber, and Sinitzin, Samuel[2] reached entirely different results. "It is certain that arterial hyperæmia, after the cutting of nerve trunks, or in the immediate neighbourhood of inflammation foci, does not cause new growth. The same holds good for venous hyperæmia."

[1] Danilewski, "Zur Frage über den Einfluss der aktiven Hyperämie auf Entzündungsprozesse" (Russian). After the detailed citation by Anton Schmidt in *Centralblatt f. Chirurgie*, 1883, p. 214.

[2] Samuel, "Die histogenetische Energie und Symmetrie des Gewebswachstums" (*Virchow's Archiv*, vol. ci., p. 389).

In a later contribution Samuel[1] asserts that the observations made by the above-mentioned physicians, contradictory to his own views, prove nothing, because the experimenters have made use of the other apparently healthy ear of the animal for the purpose of comparison. This other ear, however, is not normal, for it becomes cool and anæmic after the operation performed on the other side. Samuel believes that the operated side made use of the blood of the other, thus producing the anæmia. Against this it can rightly be said that the view that local excess of blood mechanically withdraws blood from the neighbourhood for some time can be considered as proven erroneous. As, however, Samuel, who is well known as a reliable observer of macroscopically perceptible pathologic processes, has shown lasting sinking of temperature on the apparently healthy side, and as he also relies on a number of older observers who found the same conditions, there can be no doubt as to the fact itself. In all probability, the anæmia found on the apparently healthy side is due to reflex influences. Samuel made use of entirely healthy animals for purposes of comparison, and found that the phenomena of inflammation in sympathicus paralysis occurred more rapidly and more intensely, also that they lasted a good deal longer. Samuel with this proof has certainly not successfully disproven the results of the previous investigators, who have also removed the upper cervical ganglion of the sympathicus, for Sinitzin asserts that anæmia and coolness on the non-operated side of an animal does not develop if the removal of the uppermost ganglion be added.

The most recent contribution in this domain by Liek[2] brings an absolute confirmation of the results of Snellen, O. Weber, Sinitzin, and Danilewski. Liek showed by a series of comparative experiments that Samuel's objection above mentioned to the interpretation of the healing after resection of the sympathicus is not to be considered. He found that superficial, flat, and deep-incised wounds of the ear of a rabbit healed much more rapidly when the sym-

[1] Samuel, "Ueber anämische, hyperämische und neurotische Entzündungen" (*Virchow's Archiv*, vol. cxxi., p. 396, 1890).

[2] Liek, "Ueber den Einfluss der arteriellen Hyperämie auf die Regeneration" (*Archiv f. Klin. Chirurgie*, vol. lxvii., p. 229).

pathicus was cut through, or the uppermost cervical ganglion was removed, at the same time. The regeneration took place proportionately to the degree of hyperæmia.

Liek's contribution offers the strongest proof of all, because it is based on a large number of experiments, and in spite of this the results were not contradictory, and because any objections which could be raised against the merits of the experiments have been duly considered and rejected.

Penzo[1] demonstrated in a new manner the favourable influence of hyperæmia on regeneration, in a contribution mentioned in the previous section. He constructed an ingenious apparatus in which he could keep either one ear or limb at a temperature of about 38° C., while the other could be cooled to a temperature of 10° C. The animals were removed from the apparatus for only a few hours daily. It was found that the hyperæmia produced by the warmth considerably accelerated the regeneration of open and subcutaneous wounds, while the anæmia produced by the cold retarded it. Penzo also experimented with these agents to determine their influence on fracture of the ulna in rabbits. Here the difference was extraordinarily pronounced. While on the cold side after seven to eight days not even the beginning of regeneration could be noticed, the fracture on the warmed side was already firmly united by callus, which, on microscopic examination, proved to be almost fully formed.

Thus we see that the predominant view of the experimenters is that artificial active hyperæmia considerably accelerates regeneration. If we consider that the contributions which are based on a large number of experiments very plainly show the same result, we must recognize this as fact, and can say : While the favourable influence of hyperæmia on physiologic growth of the organs and nutrition of tissue is proved only in regard to supporting tissue and cover epithelium (surface epithelium), and even this not for all cases, for other tissue, however, being at least very doubtful, it cannot be doubted that regeneration is promoted by active and passive hyperæmia.

[1] Penzo, "Ueber den Einfluss der Temperatur auf die Regeneration der Zellen, mit besonderer Rücksicht auf die Heilung der Wunden" (Moleschott's *Untersuchungen zur Naturlehre des Menschen und der Tiere*, vol. xv., p. 107, 1895).

I cannot leave these observations without asserting that in regeneration this influence by hyperæmia is proven not only for completed tissues, but also for tissues with passive functions, surface epithelium, and supporting tissue, for the scars consist of these. The fact that nerves and vessels form in the scars does not militate against it, for without them new growth cannot be imagined. We know that nerves and vessels are not excessively present in scars, and that their function leaves much to be desired.

The action upon regeneration of agents producing hyperæmia has been utilized for a long time. Thus, heat in the form of moist compresses, poultices, etc., has been used to stimulate weak granulation. For the same purpose we have numerous chemical irritants—*e.g.*, turpentine ointment, camphor wine, nitrate of silver, and Peruvian balsam.

Guyot's[1] incubators recall Penzo's experiments. This physician placed wounded limbs in an apparatus the air of which was heated to 36°. The temperature must not exceed 40°, nor fall below 20° C.

We can include here also the treatment of frost-bite by hyperæmia proposed by Ritter.[2] Ritter found the active hyperæmia produced by hot air most effective. One might conclude from this that the vascular paralysis and venous stasis—the supposed conditions produced by the freezing—were removed. This view is to be rejected because of Ritter's observations, which show that good results are also obtained with artificial hyperæmia. For this reason Ritter thinks that the hyperæmia effects a regeneration of the cells damaged or destroyed by the freezing. He does not, as is customary, look upon the hyperæmia by freezing as something obnoxious, which should be combated, but, on the contrary, as a useful and natural reaction of the body to the injury which, in the majority of instances, should be encouraged. I have become convinced by Ritter's cases that really both forms of hyperæmia have a favourable effect on the healing of frost-bite.

I myself, in the beginning of my experiments with hyperæmia, have repeatedly treated ulcers, which have not healed

[1] Guyot, "De l'emploi de la chaleur," Paris, 1842. Cited after Bardeleben, "Lehrbuch der Chirurgie," fifth edition, 1866, vol. i., p. 113.

[2] Ritter, "Die Behandlung der Erfrierungen" (*Deutsche Zeitschr. f. Chirurgie*, vol. lviii., p. 172).

by other remedies, with hot air, and I believe that the previously mentioned successes of Ullmann with infectious ulcers were due more to this effect of the active hyperæmia than to its bactericidal influence, as Ullmann believes.

In conclusion we must discuss the question, Which form of hyperæmia best promotes the building up and regeneration of the tissues? I believe the majority of physicians will answer without much thinking, "The active arterial hyperæmia." In numberless contributions one can read that "an improvement of the circulation" and removal of blood-stoppage naturally have a favourable influence on the nutrition. The observation that the functional hyperæmia accompanying the activity of the organs is active seems to support this view. In reality, this view is not at all proven, and if we here permit our schoolmistress, Nature, to talk, and accept her institutions as rational, we shall come to a diametrically opposite opinion. It has been frequently emphasized that nowhere in man can there be seen a more pronounced regeneration than in inflammation—nay, that this inflammatory regeneration, as shown by Weigert, overreaches the mark, producing in a short time in place of the injured tissue an excess of new one, so that one is justified in speaking of an inflammatory hypertrophy. Inflammatory hyperæmia, however, is not active, but passive. And do the innumerable newly formed small vessels observed in wound repair, and with the most energetic inflammatory regeneration after delivery, signify anything else but an enormous widening of the current bed with increase of the resistances, and through it slowing of the blood-current?

And if we turn to the most powerful regeneration which we know of—the development of the fertilized ovum to an embryo, and that of the latter to a mature fœtus—we shall observe, as has been shown by Bonnet's[1] investigations, the most magnificent congestion hyperæmia that we can see anywhere in the human body. The blood-current in the wide blood-spaces of the placenta is slowed to such an extent that intense œdema and extensive hæmorrhages develop in the tissues of the placenta. According to Bonnet,

[1] Bonnet, "Weitere Mitteilungen über Embryotrophe" (*Deutsche Med. Wochenschrift*, 1902, No. 30).

the embryo draws most of its food from the slowly moving blood—especially from the œdema—and from the transuded decomposing blood. Also, the rest of the food is obtained from the congested blood through dissolution of the tissue components of the mother.

As regards the function of the tissues, we have to deal with entirely different processes. Work is done principally by oxidation of the tissues, and for this a quick blood-stream is necessary, which must always supply new blood rich in oxygen. For undisturbed work it is, furthermore, necessary that the combustible products, which act as intoxicants and paralyze the active organ, be continually washed away, and this, too, is best accomplished by a powerful, rapidly flowing blood-stream.

I therefore believe we are justified in establishing the following as an axiom : Functional hyperæmia is active ; that which serves to build up tissues is, in all probability, passive. From this it must not be concluded that the cell, which intends to enlarge or increase in consequence of an unknown stimulus, cannot take the necessary food from a rapidly flowing blood-current. Much seems to indicate that function, accompanied by active hyperæmia, leads to enlargement of the active parts, and that a few of the above-cited observations and experiments show that active hyperæmia also influences favourable regeneration. But, first of all, the building of the tissues that leads to functional hypertrophy proceeds so slowly that it cannot in the least be compared to the great rapidity of inflammatory and embryonal regeneration, and, again, we do not even know whether in those cases the functioning cell takes its food from an accelerated juice-stream or not. For the inflammatory hyperæmia, too, is originally active, and the inflammatory irritation changes the originally rapid into a slower blood-current. It is not at all improbable that the unknown growth stimulus possesses the same property.

The functional hypertrophy shows a great analogy to the inflammatory one. Here, as there, an injury which causes the hypertrophy precedes the increase and enlargement of the tissue cells. Thus, Weigert,[1] the discoverer of inflam-

[1] Weigert, "Neue Fragestellungen in der pathologischen Anatomie." Gesellschaft Deutscher Naturforscher und Aerzte. Verh., 1896, Allgemeiner Teil.

matory tissue hypertrophy, has expressed the view that exercise hypertrophy is an indirect consequence of function, because it is the latter which leads to injury of cells, and this to hypertrophy.

The circumstance that the work of the tissues leads to active hyperæmia does by no means indicate that the latter is essential for the following formation of new tissue. In all probability this, too, will take its food from a slowed blood-current, for we now know that even the decomposition of our own body tissues produces inflammatory phenomena. One need only think of the subcutaneous blood-effusions, which produce hyperæmia and intense œdema, and of fever and albuminuria, which have been observed during their resorption, just as after vigorous physical exertion which led to a pronounced decomposition of body tissues. Hypertrophy, however, does not develop during work, but in the intervals of rest afterwards, and the sensation of fatigue prevents us from continuing work after great physical exertion. It seems to me very probable that, considering the relationship of both processes, the functional and inflammatory hypertrophy are both associated with a passive hyperæmia.

I do not understand how, in spite of all this, the idea took root, especially in practical medicine—with few exceptions—that a fast current of arterial blood is necessary and useful for nutrition. I believe that here the effects of labour and construction as factors have been thoughtlessly interchanged, because it was seen that function of the tissues produced an accelerated arterial blood-stream. I am not aware that anyone has already expressed the following simple, logical consideration which I propose, though I know how difficult it is to treat such things simply theoretically. But the assumption which I desire to refute is a theory supported by nothing accepted as self-evident; and therefore it should be permissible to demonstrate on what weak ground this theory is based.

Work requires oxygen, which transforms, by oxidation of organic material, chemic tension into heat and other forms of energy. As hereby high molecular combinations, poor in oxygen, are carried into the last end-products of oxidation, oxygen must be present in large quantity.

Furthermore, there is need of a rapid blood-stream, because it must always supply new oxygen and carry off carbonic acid and other products.

Certainly some measure of energy must be used up in the construction of the tissues, which in all probability is yielded by oxidation, as it represents the only source of strong energy for the human body. But the food from which tissues are built up represents so high a synthetic quality that the quantity of energy necessary for its complete assimilation can be but extremely small.

Now, in every form of nutrition, especially in the increased nutrition from bacterial stimulus, inflammation takes place in addition to construction, also considerable destruction of bodily tissues ; for there is no bacterial disease followed by inflammation which does not lead to a necrosis. In the mildest cases this is so slight that the necrosis in the interior of the cell body cannot be recognized, even microscopically. The inflammation, probably, is for the purpose of repairing the damage, and is solely produced by it. According to our experience, however, the decomposition of these necrotic parts, which makes them adapted for resorption, expulsion, or other utilization in the body, takes place, not by oxidative, but by fermentative, division. This does not mean that this ferment effect cannot take place with the taking up of oxygen, as is, for instance, the case in fermentation. But in the destruction and removal of the necrotic masses in soluble components we do not have to deal with an extensive oxidation, but with a division into highly organized combinations (albumin bodies, fats, etc.), for which as little oxidation is needed as has been above described for the process of construction. Perhaps the quantities of energy effective in construction and destruction really compensate themselves, for the energy liberated with the latter can be utilized for the former.

Taken all in all, we can conclude from these observations that for the changes which the nutritive hyperæmia has to produce no large quantities of oxygen are necessary ; there might be enough of it present in the venous blood.

I have throughout this investigation not touched upon the question whether the human body—similar to a plant—can

also create complicated combinations from simple ones. If this were the case—if the body, for example, made use of the carbonic acid of the blood for construction—considerable quantities of oxygen would be liberated by this synthesis. But when this process does take place, it is to so small an extent that we cannot deal with it. At any rate, it can be easily conceived, theoretically, that a fairly venous blood, perhaps much better than a highly arterial one, is capable of aiding nutrition. In most of the cases in which hypertrophy of bodily parts due to chronic hyperæmia has been observed, as I have just explained, the latter was of a venous and not an arterial character.

In reality, however, the question of the more venous or arterial character of the blood in nutrition is of no moment, the greater importance pertaining to slowing of the current and its consequences, which brings all tissues into more intimate relation (serous infiltration, emigration of leucocytes, etc.) with the components of blood than can the rapidly flowing arterial stream.

I again point to the embryo, which does little work, but shows an enormous construction of tissue. The embryo, however, as a consequence of its peculiar circulatory relations, must be satisfied with blood poorer in oxygen and richer in carbonic acid.

The foregoing is presented to those physicians who, as many of my colleagues have done, while acknowledging an artificial active hyperæmia, regard my efforts to cure diverse diseases with artificial passive hyperæmia as the production of a mad phantasy. Their only objection is that it is "self-evident" that passive hyperæmia represents a grave disturbance of nutrition.

In this chapter we have often referred to "irritation" (stimulus), without which no growth or regeneration takes place. What is this puzzling irritation? I believe we must, in accordance with our modern knowledge, give up the idea of investigating the stimulus of development and of bodily growth; for this is but a great part of the eternal problem of life, the solution of which has been vainly tried by the greatest minds of all times. We will therefore content ourselves with subjecting to investigation a special

manner of growth, the regeneration after injuries, which leads to their repair.

First of all, division of tissue and injury to tissue is in itself the stimulus for regeneration, according to the self-regulation effective everywhere in Nature. But this is only a circumscribing of the facts. We do not know whether, in addition to the injury, other growth stimuli are not effective, which could be artificially replaced or increased. I have occupied myself with this highly interesting biologic question, and numerous observations and fruitless experiments have led me to the conviction that, apart from the injury *per se*, there is no uniform stimulus for all tissues. I therefore paid special attention to a certain tissue—the best studied of them all—bony tissue. Medical observation during treatment of pseudarthrosis and retarded callus formation seem to have proven long ago that the mysterious growth stimulus can be replaced by simple chemic and physical stimuli. In favour of this view, attention may be drawn to the distinct success often obtained by injection of alcohol, lactic acid, tincture of iodine, oil of terebinth, the application of mechanical remedies—friction or percussion of the fractured ends, insertion of ivory pegs—in deficient callus formation.

On closer consideration, however, one recognizes that this conclusion is uncertain, for all these things, perhaps, act only mediately. They all produce a new injury or damage at the place of fracture, and we have arrived at the very point where we started, in so far that the injury and damage itself offers a stimulus for regeneration. Again, all these measures lead to inflammation—*i.e.*, an increased supply of nutritive material; compare the described artificial hyperæmia in the treatment of fracture of the bones, and an inflammatory hypertrophy in Weigert's sense.

Numerous reasons and experiences have finally caused me to regard the effusion of blood as the most prominent stimulus for the new formation of bone, and in all probability also it acts as an excellent nutritive agent for recent callus—viz., it is a peculiarity of the subcutaneous bone fracture to cause large effusions of blood. This may be, and really has been, looked upon as a harmful feature of fracture. But proofs for this have never been offered; it is one of

the many textbook dogmas which everyone considers self-understood, but which not infrequently are erroneous, and unable to stand investigation without prejudice.

The effusion of blood may just as well be useful for the healing of bone fractures, for this always takes place in association with extraordinarily large quantities of blood between and around the fracture. These represent, therefore, the natural conditions for the healing of a bone fracture.

Like many other surgeons, I learnt by experience that recent fractures in the territory of the diaphyses, which I had sutured for faulty position, required much more time for healing than the subcutaneous ones. As an explanation for this striking fact, it has been asserted that the exact adaptation of the fragments retards the formation of callus. Since we now place the fragments of subcutaneous fractures more exactly together, under control of the Röntgen rays, and yet, in spite of this, do not observe any retardation of callus formation, this explanation does not hold good, especially as Bardenheuer, who, ahead of all other surgeons in this territory, has aimed for a long time at an exact apposition of the fracture ends, reports that with his immense material he has not observed a single pseudarthrosis.

The reason for retarded callus formation in these cases is now clear to me. We cleaned out the blood-effusion, and carefully arrested the hæmorrhage.

A similar condition prevails in compound fractures, which, too, do not heal very well, even when they escape infection. The effusion of blood is evacuated through the soft tissues.

A series of measures which have been used for the cure of pseudarthroses produce small effusions of blood around and between the fracture ends—for instance, forceful friction under anæsthesia and percussion.

This struck me forcibly when I made successful use of the fairly severe method of Thomas—the so-called percussion—in a few desperate cases of pseudarthrosis.

Not infrequently we observe that a bone (especially the tibia), when it sustained a blow which led to an effusion of blood, later showed pronounced thickening of the bone.

Bone fractures causing extraordinarily large effusion of blood frequently heal with intense callus formation. Again, in several cases of fracture with slight effusion of blood, I observed that knitting did not occur for some time.

Blood-effusions in the muscles are responsible for the development of so-called drill and riding bones.

Extensive effusions of blood produce considerable new formation and granulation in other connective substances. They lead to the formation of large callosities, for which reason special stress is justly laid on the early removal of the effusion, to avoid these callosities.

Observation everywhere indicates that wherever there is a large effusion of blood considerable new formation of bone and connective tissue develops.

I have tested these theoretic considerations in practice. I reported[1] that I quickly produced a cure in a whole series of fractures which showed no inclination to heal, by injection of blood of the same patient, taken from one of the veins of the arm. I could now add another series to that then reported.

I believe thus to have introduced into practice the most natural and most effective method of dealing with troublesome retarded callus formation.

The blood soon after its injection produces an inflammation. The region of the fracture becomes œdematous and swollen, painful to pressure, reddened, and considerable increase of surface temperature can be observed for many days with sensitive instruments, which phenomenon, by the way, can also be discerned with the bare hand.

I think it possible that the effusion of blood has a nutritive effect not only indirectly, but also directly, because the young cells of the callus absorb it, and make use of it for construction.

It is said that the tissue cells in regeneration resume an embryonal character. Now, Bonnet, in his contributions previously mentioned, has shown that in the deciduates the embryo draws a good deal of its nutrition from the blood-effusion of the mother's placenta. Kolster[2] found that effused blood from the vessels of the mother is found as a component of the so-called "uterine milk" of the indeciduates, which is itself regarded as nutritive material for the embryo. If we ascribe to the young callus embryonal

[1] Bier, "Die Bedeutung d. Blutergusses f. d. Heilung des Knochenbruches. Heilung v. Pseudarthrosen u. verspäteter Kallusbildung durch Bluteinspritzung" (*Med. Klinik*, 1905, Nos. 1 and 2).

[2] Kolster, "Die Embryotrophe plazentarer Säuger" ("Merkel u. Bonnet's Anatomische Hefte," vol. xx., No. 59).

properties, the assumption is probable that, like the real embryonal cells, they take up by means of osmosis and phagocytosis the food offered them in the blood-effusions and utilize it. A similar condition may exist when, after tenotomy, a new piece of connective tissue replaces the blood-coagulum connecting the two tendon stumps.

It would be, however, erroneous to extend these views to all tissues. The healing of a fractured bone occupies to a certain degree a peculiar position ; it takes place through a tissue which usually disappears later on—callus. This injury is not at all adapted for a *prima intentio*, in a strict sense of the word ; the injured bone, on account of the demand made on it, needs a provisional, protecting callus mass, which supports it, and enables it to resume its function until its inner firmness has so far progressed that it can dispense with the provisional cementing. Then the resorption of the callus takes place.

In the large majority of tissues, however, healing should take place *per primam intentionem*, and this is made impossible by large effusions under any circumstances. They lead, as I have pointed out, to development of a callous connective tissue, which can be compared to the bone callus, but which is here as obnoxious for function as callus is useful to that of the bone. For this reason it is right to remove effusions of blood into tissues as much as possible.

These considerations were for me the main reason for the assumption that, apart from the injury itself, the different stimuli for regeneration cannot be used interchangeably in variable tissues.

I know that I have not exhausted with this small contribution the essential nature of the growth stimulus for bone callus. For when I say the effusion of blood is stimulus, and indirectly (perhaps also directly) nutritive material for the formation of callus, it, too, is only a circumscription of facts, as is the assertion that section of tissue as such institutes regeneration. But almost all our medical and naturalistic " explanations " are of this kind, and in so dark a territory as the one under consideration, any such circumscribing explanation, if it brings us nearer to an understanding of the things, is a decided progress.

APPENDIX

THE INFLUENCE OF THE TOTAL BLOOD FOR CURATIVE PURPOSES

Until now we have only treated the question of how to make use for curative purposes of the blood placed at our disposal by the patient, without paying any attention to its quality. Naturally, the tissues, and especially the blood, of the patient are frequently unhealthy ; for if they were perfectly healthy, diseases like tuberculosis, chronic rheumatism, and numerous acute infections, would not have attacked them at all, in all probability. It would therefore be of tremendous importance if we had at our command a remedy which would so improve the whole blood that these diseases would either become impossible, or, if once established, could be cured.

It is evident that with any improvement of the doby that of the blood must go hand in hand. For each cell receives its nutrition from blood, and without healthy blood there will never be a healthy body, though we cannot say that improvement of the blood must always precede improvement of the body. For in the human body the one always depends upon the other, and without the necessary stimulation of the blood-forming organs there is no improvement the blood.

The correctness of the old view concerning the decisive influence of the condition of the blood on the course of diseases, especially those due to infection and metabolism, have been brilliantly confirmed by modern research.

From a purely theoretic point of view, treatment which increases the strength of resistance and attack of the entire body, and in the first place of the blood, so that it is enabled

to overcome the antagonistic disease, especially of affections which do not remain local, such as tuberculosis or gout, and chronic articular rheumatism (which evidently are due to internal causes), is the ideal method.

To this must be added the fact that an improvement of the blood would put us in a position to apply our methods of local hyperæmia with greater prospects of success. In that respect this chapter is cognate to a book such as this.

The idea of improving the blood is as old as medicine itself. It is only of late that it has been placed in the background, since Virchow's teachings of the localization of disease has forced the physician to purely local treatment, and since, under the influence of the same teacher, the views about humoral pathology have become more and more discredited.

However, Virchow's cellular pathology is gradually losing its monopoly, and one must indeed be blind not to see that many of us are cultivating humoral pathologic views, though in an entirely different sense than in those older days when humoral pathology reigned as supreme as did cellular pathology in more recent times. This change does not detract in the least from the fame of the teachings of the great master Virchow.

Cellular pathology, accompanied by the dogmatism and the one-sidedness with which it has frequently been taught, was a necessary and useful theory for the time being, for it has proved itself fruitful for medicine, and few other doctrines before it have removed so much superstition and so many false views. Its pillars stand unshaken even to-day. This, however, must not mislead us to swear by cellular pathology in rigid orthodoxy as the only true doctrine, and to fail to appreciate its older sister theory—for theories they both are—with its many correct ideas.

Having regard to my contributions, which have been regarded by many as representing humoral pathology, I have frequently been asked whether I confess myself a humoral or cellular pathologist. To this I answer, according to my naturalistic standpoint, I am unconditionally a cellular pathologist and cellular physiologist, for, according to our present knowledge, the cell is, and remains, the only living thing in the human body with which all phenomena of life are associated, and which determines and regulates the composition of the serum in the body. Nevertheless, it is by no means necessary to underestimate the significance of the serum. This idea never came into Virchow's head, for he thinks it possible that

the serum plays a rôle in the development of cellular tumours. Compare Virchow, "Die Krankhaften Geschwülste," vol. i., pp. 59, 87, 88, Berlin, 1863.

The question is, whether it is permissible to dogmatically and unconditionally apply so purely a scientific standpoint to one's practical activity. I, for my part, consider it a malicious subtlety when one asserts that the influence and the composition of the bodily serum—by, for instance, Behring's serum or by dietetic cures—is to be regarded as purely cellular pathology. Or perhaps that the method of cure described by me in this book is pure cellular pathology or cellular physiology because blood is tissue. Scientifically this may be defended ; but natural, practical common-sense says that the blood, in spite of its many cells, is a serum, and that its employment for purposes of cure means neither purely humoral nor purely cellular pathology, but, if a term has to be decided on, hæmopathology.

Undoubtedly, the application of Virchow's cellular pathology, which scientifically stands unshaken even to-day, in our daily practical work as physicians means a great progress. But this tendency is completely used up, has been brought to a standstill, and, in my opinion, has lately proved itself as fairly barren for practical medicine. Why, therefore, should we not think for awhile humoral-pathologically, as long as this mental activity carries us forward ? And if later someone as a neuropathologist will open for us new views and new avenues, why not think neuropathologically ? Virchow himself ("Cellularpathologie") says of humoral pathology : "In the development shown by medicine to date we find the quarrel between the humoral and joint schools of the old time still preserved. The humoral schools, generally speaking, have had the most luck, because they have given the most convenient explanation, and, in fact, the most plausible interpretation of the morbid processes. One can say that almost all lucky practitioners and eminent clinicians have had more or less humoral-pathologic tendencies." Virchow further says : "According to my conception, the standpoint of both doctrines is incomplete. I do not say it is a false one, because it is just false in its exclusion, but must be reduced to certain limitations, and one must remember that alongside of vessels and blood, alongside of nerves and central apparatus, there exist other things which are not a substratum of the effects of the nerves and blood."

Lately some physicians pay more attention to general treatment. Many never neglect it ; I give here the names of such men as Brehmer, Dettweiler, Winternitz, Oertel. The representatives of so-called natural healing (Schwenninger, Lahmann) have strongly, and often excessively, represented the standpoint that in the treatment of diseases, and even of many so-called "local" diseases, consideration of the entire body must be paramount. In popular medicine laymen have never ceased to believe in the healing effect of general improvement of the blood. For this reason so-called "blood-purifying" and "blood-improving" remedies are highly respected by the people.

Nowadays all physicians undoubtedly give the first place to general hygienic conditions, such as light, good air and nutrition, for the maintenance and regaining of health. The

most important of these three things is nutrition, both qualitatively and quantitatively. Every cattle-breeder knows that, next to right choice of parents, the labour capacity and improvement of the animal races is above all a question of nutrition.

But the so-called "good" nutrition does not suffice as far as diseases are concerned. Experience has taught us that for certain diseases certain forms of diet are indicated. We are interested in those which, in the first place, have an effect on the composition of the blood. To this belong the various withdrawal cures, especially Schroth's cure, which enjoys a great reputation in just those diseases which are favourably influenced by local hyperæmia—that is to say, chronic rheumatism and tuberculosis of the bone with sinuses. My friend Dr. Dittrich, of Schönberg i. H., writes me that he has obtained excellent results in the treatment of these diseases by a combination of Schroth's cure with agents producing hyperæmia, and explains that by Schroth's cure altered and improved blood is accumulated at the diseased part. I have not experience enough to judge of the value of this cure. Among the old methods for the "improvement" of blood are venesection and wet cupping, which in scientific medicine to-day have been relegated to the background, at least as blood-tonics. Venesection is even to-day very zealously upheld by the county physician Bachmann,[1] of Harburg, whose successes by means of the withdrawals of small quantities of blood seem to me worthy of attention. I myself have occasionally used venesection with pronounced success, but have not sufficient experience to express a decided opinion. Generally speaking, I hold the view that all popular remedies which have not been exterminated in the course of centuries contain an element of truth.

In all probability, many other general remedies, some medicinal agents, but especially baths, air, light, sun-baths, change of climate, etc., affect the blood, and by means of it influence local diseases. Practice has demonstrated

[1] Bachmann, (1) "Der Dyes'sche Aderlass in Theorie u. Praxis" (*Deutsche Medizinalz.*, 1898, Nos. 17-21); (2) "Weitere Erfahrungen mit d. Dyes'schen Aderlass" (*ibid.*, 1898, Nos. 96-98); (3) "Eine dritte Serie v. Aderlassfällen nach D'. Methode" (*ibid.*, 1900, No. 43); (4) "Heilgn. v. Unterschenkel-Geschwüren u. Ekzemen durch d. Dyes'schen Aderlass" (*Therap. Monatshefte*, 1900, April).

their undoubted healing effect. To be convinced, one need only look at an individual afflicted with tuberculosis of the bones with sinuses, and totally emaciated, who after taking a course of sea-baths not only recuperates, but also loses his local trouble.

Certainly we as yet lack a sufficient explanation and a solid scientific basis for these phenomena. For this reason we shall turn to newer experiments which have been undertaken with the definite intention of altering the blood or certain of its components, and in that way effecting cures. I will here exclude the methods which incorporate in the blood specific remedies, such as the intravenous injection of corrosive sublimate for syphilis, and the subcutaneous incorporation of specific serum, tuberculin, etc.

In this connection we must mention Landerer's[1] well-known experiments to cure tuberculosis by intravenous injections of cinnamonic acid. Landerer believed that the remedy acts by the production of a leucocytosis. The leucocytes gather around the tubercular foci, and form a solid wall around the infected area; granulation tissue and bloodvessels develop, the tubercular masses are absorbed, their place being occupied by connective tissue. Landerer believed that the mode of action in the injection of cinnamonic acid consists of a leucocytosis, and the production of an acute inflammation around the tubercular masses. Landerer's proposition has found many adherents, of whom I will mention but a few. Löwy and Richter[2] injected leucotactic agents, pilocarpin and albumose-like bodies, especially spermin, into the veins of animals, and observed the favourable influence on the course of artificial infection.

Hahn[3] demonstrated that the blood of men and animals

[1] Numerous articles, of which I mention the following:

Landerer, (1) "Die Behandlung der Tuberkulose mit Zimtsäure," Leipsic, F. C. W. Vogel, 1892; (2) "Weitere Mitteilungen über die Behandlung d. Tub. mit Zimtsäure" (*Deutsche Med. Wochenschrift*, 1893, Nos. 9 and 10); (3) "Der gegenwärtige Stand der Hetol- (Zimtsäure-)Beh. d. Tub." (*Berliner Klinik*, 1901, No. 153).

Richter, "Histol. Untersuchungen über d. Einwirkung d. Zimtsäure auf tub. Kaninchen" (*Virchow's Archiv*, 1893, vol. cxxxiii.).

Landerer, "Neuere Erfahrungen über Hetol u. Hetokresol," Biebrich, Kalle and Co., 1892.

[2] Löwy and Richter, "Über d. Einfluss v. Fieber u. Leukocytose a. d. Verlauf v. Infektionskrankh." (*Deutsche Med. Wochenschrift*, 1895, No. 15).

[3] Hahn, "Über d. Steigerung d. nat. Widerstandskraft d. Erzeugung v. Hyperleukocytose" (*Archiv f. Hygiene*, vol. xxviii., p. 312, 1897).

in whom a hyperleucocytosis has been produced by an injection of leucotactic agents has stronger bactericidal properties than normal blood.

As these experiments seem to show that the hyperleucocytosis has a healing effect, not only on tuberculosis, as was intended by Landerer, but also on all other possible bacterial infections, Mikulicz[1] made practical use of it to protect human beings against septic infection after dangerous operations, especially laparotomy. He made use of nucleinic acid as a leucotactic remedy, which was injected some time before the operation. He believes he obtained favourable results in so far as difficult abdominal operations, which included the danger of infection, ran a favourable course.

Great hopes were entertained after these alleged successes in men and animals, and much was expected from these agents for the increase of leucocytes. Certainly also there is no lack of opposition. Goldscheider and Jacob,[2] who have made experiments similar to those of Löwy and Richter, come to the conclusion "that the artificial production of hyperleucocytosis will scarcely yield anything beneficial for human therapy." Also they do not consider the artificial change of the relation of leucocytes to be entirely free from risk. At any rate, we have here to deal with pure experiments, which so far offer nothing reliable for the treatment of human diseases.

It is very interesting that in this domain also practice has apparently preceded theory, in so far as very old remedies, the so-called revulsiva, have evidently acted in a like manner. Undoubtedly the seton, the issue, the cautery, and other similar things, not only produced inflammation and suppuration at the place of application, but also hyperleucocytosis in the entire circulation exactly as the modern remedies mentioned above, and perhaps still more energetically. In this manner, we can gain a suggestion with regard to the inexplicable remote effect of these remedies. The revulsiva, in contradistinction to the derivans, were

[1] v. Mikulicz, "Versuche über Resistenzvermehrung d. Peritoneums gegen Infektion bei Magen- u. Darmoperation," Verh. d. D. Ges. f. Chir., Thirty-third Congress, 1904, vol. ii., p. 26.

[2] Goldscheider and Jacob, "Beitrag z. Lehre v. d. Phagocytose" (*Fortschritte d. Med.*, vol. xiii., 1895, addendum, p. 357).

applied at a distance from the diseased focus, which led to their being rejected as ineffective. It is certainly not proved that these agents act only by hyperleucocytosis, and not also by other effects. One is nowadays too much inclined to glorify and to generalize one-sided microscopic and bacteriologic investigations, which frequently have all the ear-marks of laboratory erudition, as we have had occasion to learn in this book.

Modern research has a short memory. As far as my knowledge of the literature goes, it does not mention these methods when considering the productions of general hyperleucocytosis. I induced Plaskuda[1] and Göbel[2] to undertake the saving of the honour of these old healing agents.

Should the conception of the healing effect of hyperleucocytosis be confirmed, one sees here again that a physician should honour the remedies which have lasted through thousands of years.

Heile[3] believes himself able to strengthen the effect of leucocytosis by a new means—that is, by subjecting animals to Röntgen rays. The leucocytes afterwards become disintegrated, as can be seen from the experiments of Heineke cited above ; and the enzymes attached to them are liberated, and, according to Heile, kill the bacteria.

We see that in acute infectious diseases the body gets rid of the intruding enemy by an heroic effort, to the individual phenomena of which we have given the collective name "fever." Since the revival of the old view that fever is a useful process of reaction of the body against intruded injuries, it has been consistently tried to make use of artificial so-called "healing fever" in the treatment of diseases. The first experiments suffered from the error of imitating one phenomenon only of the fever—the rise of temperature. Buchner[4] produced real fever in animals by the injection of a sterilized emulsion of Friedländer's capsular bacilli, and cured by means of it malignant pustule,

[1] Plaskuda, "Einige alte Behandlungsmethoden in moderner Beleuchtung," Inaug. Diss., Greifswald, 1903.

[2] Göbel, "Über d. hyperleukocytoseerregende Wirkung hautreizender Mittel" (*Med. Klinik*, 1906, No. 1).

[3] *Loc. cit.*

[4] Buchner, "Über Hemmung d. Milzbrandinfektion und über d. aseptische Fieber" (*Berliner Klin. Wochenschrift*, 1890, No. 10).

which otherwise would have been fatal. I[1] believe myself to have been the first to induce in patients fever with all its phenomena. I produced fever by intravenous injection of foreign blood (wether-blood). In this I availed myself of the experience with the old transfusion of animal blood, which has been undertaken with the erroneous intention of replacing the blood of the man by that of another species. We now know from Landois and Bordet that the blood of the giver becomes immediately decomposed by that of the receiver.

I avoided the mistake of the old transfusion, measured the dose of the blood exactly, and considered in repeated injections the newly acquired hæmolytic properties of the receiver. Transfusion of animal blood produces an artificial acute infectious fever, which shows all the phenomena of a natural fever—viz., first chill and rise of temperature; second, increased decomposition of albumin and increased metabolism, produced by a decomposition of the blood, which later, in all probability, has a destructive effect on bacteria; third, after passing of the rise of temperature, increased appetite and consumption of food. But in every other respect the entire process has completely the character of an acute infectious disease. Agglutinins and hæmolysins are formed for the foreign blood-corpuscles and for the foreign blood; acute splenic tumour develops, and, if a large quantity of foreign blood has been used, also albuminuria, hæmoglobinuria, and hyperæmia of the diseased parts (also those chronically afflicted). It is this last phenomenon, indeed, which imitates the acute infectious disease; for in pneumonia—at least, before the stage of hepatization—the lung becomes intensely hyperæmic, as does the peritoneum in peritonitis, and the skin in scarlet fever and smallpox.

There is even no lack of the troublesome phenomena accompanying some of the acute infectious diseases. We frequently observe vomiting, pains in the back, exanthemata, herpes, and diarrhœa.

Injected locally into the tissues, foreign blood produces

[1] Bier, "Die Transfusion v. Blut, insbesondere von fremdartigem Blut, und ihre Verwendbarkeit zu Heilzwecken v. neuen Gesichtspunkten aus betrachtet" (*Münch. Med. Wochenschrift*, 1901, No. 15).

the most violent inflammation I know of. Each subsequent injection produces a still greater inflammation. As this artificial inflammation by foreign blood is at the same time the most harmless, I have frequently and successfully made use of it in order to influence favourably diseases. I shall report this in greater detail at some future time.

I have with two exceptions subjected to this blood-transfusion only such patients as were candidates for death, and a few were afflicted with the worst form of incurable lupus. I have seen striking improvement in the gravest form of pulmonary consumption. In one case the colleague in charge of the patient was greatly surprised at the incredible retrogression of the objectively demonstrable grave changes in the lungs and at the improvement of the general conditions. The places attacked by lupus became covered with scabs, and the ulcers under them with skin, so that they could be regarded as cured. It is to be regretted that a lasting cure of lupus was not effected in one instance. After the treatment was discontinued, a recrudescence occurred quickly. Certainly, they were hopeless, very severe cases.

Dehio,[1] reasoning from the same standpoint as I, conducted later similar experiments with different agents. He chose for the production of fever at first bacterial proteins, and later albumoses, according to the process of Matthes and Krehl. He injected the substances subcutaneously. He, too, observed the favourable effect of the artificial infectious disease, which, according to the description, is similar to that produced by foreign blood. He cured seven out of fourteen patients, but scraped out the ulcers with a sharp spoon in addition to the other treatment. The experiments, therefore, are not pure. Dehio reports three cases which have remained well for from six months to one year. I fear that after this brief observation they, too, suffered a relapse, just as happened in my cases which I had considered cured.

Dehio was able to demonstrate a favourable influence of the injections also on other infectious diseases.

[1] Dehio, "Über Heilwirkungen d. künstl. hervorgerufenen Fiebers bei verschied. Krankh.," Therap. Versuche (Transactions of the Kongress f. Innere Med., Twenty-first Congress, 1904, p. 478).

I am fully aware that this chapter is the most imperfect and unsatisfactory in the entire book. This is easily understood if one consider that, on one hand, I, as a surgeon, do not possess the requisite experience in these things, and, on the other hand, our knowledge in this domain is extremely limited, almost everything being yet to be done. Practice, however, has unmistakably shown the efficacy of the general blood-improving agents. Theoretical research, animal experimentation, and the limited experience with man, give us the hope that we shall yet achieve success with measures which alter the blood for a definite purpose. When I said in the beginning of this chapter that the general treatment of certain diseases, which we now attack by local measures, is theoretically ideal, we must also confess that this ideal has by no means been achieved in practice. As an illustration of this I select surgical tuberculosis. For the splendid results which we obtain in this disease with local remedies, as I will show in a subsequent chapter, even when the external circumstances are very unfavourable, we never obtain by general treatment, no matter how skilfully it may have been administered. And yet tuberculosis is the disease for which at this time, following Brehmer's lead, the general treatment is placed in the foreground.

In practice both methods, general and local treatment, should be combined as much as possible.

SPECIAL SECTION

TREATMENT OF DIVERSE DISEASES WITH HYPERÆMIA

Preliminary Remarks.

In the following chapters, which are to treat of the therapy of diverse diseases with artificially produced hyperæmia, I do not intend to cite and discuss all the cases treated, for they are so numerous that they alone would fill a large volume. I am here concerned especially in the discussion of the technique for those diseases which have been successfully treated with hyperæmia. I will give histories of cases only in those instances where the effect of hyperæmia is not yet generally recognized.

I also deem it superfluous to report a series of cases which we have experimentally treated with hyperæmia, but where our experience is so meagre, or so deficient, that positive conclusions were not reached.

I remark, however, that the territory of application of hyperæmia, this grand general curative agent, has become enlarged from year to year, and in all probability will be still more enlarged.

A few general remarks may be made. Any remedy, be it chemical or physical, acts differently in proportion to the dose in which it is administered. A medicinal remedy useful in a small dose may become injurious, even fatal, as the size of the dose is increased. H. Schulz[1] has shown that there exists in this respect a regular law. He proceeded from the biologic axiom established by Arndt for normal conditions, that is based on a generalization of

[1] H. Schulz, "Pharmakotherapie," in the "Lehrbuch der allgemeinen Therapie," by Eulenburg and Samuel.

Pflüger's "twitch law," as follows: "Small stimuli fan the activity of life, medium large ones further it, strong ones impede it, and the strongest destroy it." Schulz emphasizes that this law holds good also for the effect of medicines and poisons, and that it does not lose its validity when applied to pathological conditions. For the latter case it must be borne in mind that for diseased organs the stimuli may be strong when they can scarcely be considered so for healthy organs.

This difference in effect on the body evidently holds good also for the physical remedies, perhaps to a greater degree than for the mild medicinal remedies. One need only think of cold water, where success depends entirely on the intensity and length of application, the least error being sufficient to change the healing effect into one apt to produce sickness.

If we consider the two methods principally treated of in this book, the active hyperæmia by hot air and the passive by congestion with a bandage or suction apparatus, we come to the same conclusion. I have mentioned that the former, applied daily one or at most two hours, is one of the most important resorptive agents, and have shown this effect principally in the resorption of œdemata. On the other hand, I have shown in my first and larger contributions in 1893 that hot air of 100° C. applied to a portion of the body for seven to ten hours produces intense forms of œdema.

Congestion hyperæmia of a medium degree is one of the best pain-relieving agents in diverse affections; if an excessive degree be applied, it, on the contrary, produces violent pain and the most disagreeable sensations. The same method of a medium degree again favourably affects a number of acute and chronic local infectious diseases; if, however, it be applied too intensely, it injures the same diseases, or even produces them. If we wish to use our agents against disease, we must always remember this, and by experience must ascertain to what degree, and of what duration, they may and can be applied in each individual disease. We must consider also that, just as do medicinal substances, our agents produce variable reactions in different individuals—that what is to one a weak stimulus may be a strong one to another.

TREATMENT OF LOCAL INFECTIONS WITH HYPERÆMIA

For the treatment of infections, as I have repeatedly mentioned, congestion hyperæmia is first in value; for it is, together with its sequelæ, the truest imitation of the natural process of inflammation. It increases the already existing slowing and widening of the current, leads to serous infiltration of the affected tissue, to emigration of leucocytes, etc.

Theoretically considered, however, one must fear that active hyperæmia, representing the opposite of inflammatory hyperæmia, disturbs the natural healing process and aggravates the disease. In entire contradistinction to this we learn that since time immemorial up to the present day heat has been employed for local infections, and though it has been occasionally neglected, and even opposed, in scientific medicine, it has always regained recognition; while in medical practice and popular medicine it has never been neglected. This beneficial effect of heat, which undoubtedly represents an actively hyperæmizing agent for healthy bodily areas, can be appreciated when we consider that inflamed bodily parts have the ability to slow the blood-current in a manner not yet understood. Every remedy, therefore, which leads to a dilatation of the blood-vessels is eventually of help to the inflammatory process. But the remedy must not produce too intense an active hyperæmia, as is done by hot air, which of late has been recommended also for acute inflammation from many sources. I believe I was the first to employ hot air in the treatment of inflammatory diseases, but I have abandoned it—at least, for really acute inflammations. If it is desired to apply heat in these affections, it is better to select a Priessnitz compress, hot-water bag, thermophors, cataplasms, because they produce a less intense active hyperæmia, as has been demonstrated in the General Part.

And, indeed, a wide experience has taught me that congestion hyperæmia acts more energetically against all bacterial infections, especially the acute ones. The rule

can, therefore, be generally laid down : *Passive hyperæmia should be employed in bacterial, active hyperæmia in non-bacterial diseases.*

Of course no sharp line can be drawn. In several bacterial diseases active hyperæmia could be employed with greater usefulness, while in many non-bacterial affections, as I shall afterwards demonstrate, passive hyperæmia is to be preferred. To this must be added that with some diseases which we treat with hyperæmia—*e.g.*, chronic articular rheumatism—we do not even know whether they belong to the infectious diseases or not.

The sequelæ, however, must be sharply separated from the recent acute infections. Thus, a necrosis following acute osteomyelitis or phlegmons, or stiffening of joints following gonorrhœal infection, can be treated with hot air as soon as the acute phenomena have disappeared. It accelerates the demarcation and loosens the stiffening in an excellent manner.

TREATMENT OF TUBERCULOSIS

I WILL begin with the treatment of joint tuberculosis, because it was the first disease for which I applied hyperæmia. In my opinion, passive hyperæmia only need be considered as a therapeutic agent for these cases. I consider intense active hyperæmia very injurious here, as has already been repeatedly discussed. As a general rule, I have seen the symptoms aggravated by its application.

I got the idea of applying hyperæmia for tuberculosis from the following observations made by older physicians : Farre and Travers in 1815, and Louis in 1826, called attention to the frequent appearance of pulmonary stenosis in phthisis, explaining it by the pronounced anæmia of the lungs which this form of heart disease produces. The observations of those physicians have been confirmed without exception, so that Frerichs[1] could pronounce the dictum : " Pulmonary tuberculosis, be the relation of this disease to tuberculosis what it may, is the usual end in diseases of the pulmonary

[1] " Uebersicht über die Ergebnisse der med. Klinik zu Breslau " (*Wiener Med. Wochenschrift*, 1853, No. 53, p. 635).

artery." On the other hand, Rokitansky[1] maintains that diseases of the heart, accompanied by fullness of blood in the lungs, offer immunity against tuberculosis. Here follow his own words :

"A relation of hypertrophy of the heart to tuberculous disease is shown by the result of numerous observations. Out of 143 cases (simple, eccentric, as well as concentric hypertrophy), I find in fifteen cases there is a now extinct tuberculosis of the lungs. In all other cases—persons of variable age, sex, occupation, etc.—there never was a tubercle, from which can be concluded that both diseased conditions cannot exist at the same time in one and the same individual, and especially that in the presence of the named disease of the heart no tuberculosis, especially pulmonary tuberculosis, can develop."

The same immunity against tuberculosis Rokitansky ascribed to people with distortions of the spine, in whom, as is well known, pronounced stases develop in the circulation of the lungs. Here, too, I will quote Rokitansky :[2]

"At first we were surprised by the absence of any trace of suspected phthisis pulmonalis in the corpses of persons with distorted spines. After these observations have increased to a considerable number, this noteworthy find in each individual case, because of its constancy, suggests the rule that in distortions of the spine, tuberculosis, and especially pulmonary tuberculosis, does not occur."

Rokitansky gives statistics in support. He found among fifty of his post-mortems of cases belonging hereto, no more than three in which tuberculosis was present at the same time, cases in which insignificant distortions and deformities of the thorax only were present.

Rokitansky's observations have been repeatedly confirmed, but have also been much attacked. I will not cite from the prolific bibliography the contributions by the followers and opponents of Rokitansky's doctrine. I only remark that the large majority of physicians who have expressed themselves on this subject do not allow Rokitansky's assertions to stand in so comprehensive a way as he has expressed them, but nevertheless acknowledge the correctness of the principle, and admit a relative immunity of congested lungs against tuberculosis. Those of the readers who are interested in this question I refer to a portion of the literature

[1] *Medizinische Jahrbücher des k. k. Oesterreichischen Staates*, vol. xxvi., or of the new series vol. xvii., Vienna, 1838, p. 417.

[2] *Loc. cit.*, p. 419.

found in the bibliographic references.[1] I can well omit to discuss those observations, for they served me only as the inspiration of how to treat a single disease with hyperæmia. The experience I gained thereby compelled me to apply this treatment to numerous diseases, turning the whole question into a different domain.

My first contribution on the treatment of tuberculosis with hyperæmia I published in the year 1892.[2] I described it in detail in larger contributions which appeared in 1893[3] and 1894.[4] My last publication on the subject appeared in 1895.[5] Since then I have published no further details on the treatment of tuberculosis, because we were continuously occupied with experiments to discover the right technique of congestion hyperæmia for this disease, for with no other affec-

[1] 1. Lebert, "Ueber den Einfluss der Stenose des Conus arteriosus, des Ostium pulmonale und der Pulmonalarterie auf Entstehung von Tuberkulose" (*Berliner Klin. Wochenschrift*, 1867, Nos. 22 and 23).

2. Eymann, "Ueber die Kombination von Phthise und Herzfehler," Inaug. Diss., Würzburg, 1886.

3. Frerichs, *loc. cit.*

4. B. Schultze, "Beitrag zur Statistik der Tuberkulose verbunden mit Herzklappenerkrankungen," Inaug. Diss., Kiel, 1891.

5. Frommolt, "Ueber das gleichzeitige Vorkommen von Herzklappenfehlern und Lungenschwindsucht" (*Archiv f. Heilkunde*, 1875, No. 12).

6. Bamberger, "Lehrbuch der Krankheiten des Herzens," Vienna, 1857, p. 204.

7. Traube, "Gesammelte Beiträge zur Pathologie und Physiologie," vol. ii., No. 47, p. 748.

8. v. Dusch, "Lehrbuch der Herzkrankheiten," Leipsic, 1868, p. 185.

9. Rühle, "Die Lungenschwindsucht" (v. Ziemssen's "Handbuch," vol. v., second edition, part ii., p. 35.

10. Stalherm, "Ueber Kyphose und ihre Beziehungen zu den Veränderungen der inneren Organe," Inaug. Diss., Kiel, 1892.

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13. Otto, *Virchow's Archiv*, vol. cxliv.

14. Burwinkel, "Chronische Herz- und Lungenleiden in ihren Wechselbeziehungen" (*Deutsche Medicinalztg.*, 1902, No. 34).

15. Kuhn, v. Leyden, Westenhöffer, im Verein f. Innere Med., session of June 11, 1906 (*Deutsche Med. Wochenschrift*, 1906, No 29, p. 1177).

[2] Bier, "Ueber ein neues Verfahren der conservativen Behandlung von Gelenktuberculose" ("Verh. d. Deutschen Ges. f. Chirurgie," 1892, vol. i., p. 91).

[3] "Behandlung chirurgischer Tuberkulose der Gliedmassen mit Stauungshyperämie" (v. Esmarch's Festschrift, Kiel and Leipsic, 1893, p. 54).

[4] "Weitere Mitteilungen über die Behandlung chirurgischer Tuberkulose mit Stauungshyperämie" ("Verh. d. Deutschen Ges. f. Chirurgie," 1894, vol. ii., p. 94; and *Archiv f. Klin. Chirurgie*, 1894).

[5] "Behandlung der Gelenktuberkulose mit Stauungshyperämie" (*Berliner Klinik*, November, 1895).

tion, at all suitable for treatment with hyperæmia, did we experience so much difficulty in working out the technique as with tuberculosis. Of special importance here is the fact that an incorrect application of congestion hyperæmia may become very injurious. It is therefore important, if this remedy is to be widely used by the general practitioner, to give plain and exact rules for the application of the process, and to so arrange them that even the inexperienced can do no harm. I believe that we have now so perfected and simplified the technique, after many years of experimentation, that harm from this agent can be avoided. I deem it advisable to describe briefly the process of the development of the technique.

In the beginning I made daily applications of congestion hyperæmia of one or several hours' duration, but soon changed to a prolonged application. (The process has already been described on pp. 65 to 68.) The bandage was worn day and night, but twice daily the bandage was changed to different places to avoid pressure. Usually it was removed only once a week. I then permitted the affected parts, which were in a condition of swelling and œdema, to regain their size in order to demonstrate and watch any change in the diseased limb. The results of the treatment were variable, splendid successes alternating with failures, also cases where congestion hyperæmia alone proved inefficient, necessitating other conservative or operative measures. In almost all cases the improvement following the first application of the remedy was striking; pain disappeared, existing contractions were loosened, even the mobility of diseased joints improved considerably. Tuberculous patients, who previously could make no use whatever of their diseased limbs, were frequently able after a few days to undertake some light work. But I had to report to the Surgical Congress, which met in 1894, some disagreeable and dangerous accidents produced by the congestion hyperæmia in tuberculous limbs. The most frequent complication was the occurrence of cold abscesses, which evidently were furthered to a great degree by the congestion hyperæmia. Rarely the abscesses appeared without symptoms; in the majority of the cases the course was highly characteristic. After an immediate improvement in the tuberculous joint

the patient suddenly complained of pains which appeared in a definite place, sensitiveness to pressure in that place being great. On removal of the bandage after the œdema and swelling had subsided, the incipient abscess could be recognized by the evident fluctuation. At any rate, when the congestion hyperæmia was continued, the abscesses under the hyperæmia grew more rapidly, and became more numerous than we have ever seen them before, so that no doubt existed that they were produced by the congestion hyperæmia.

I have assumed that this *per se* is no bad sign. I saw in the appearance of the abscesses an effort on the part of Nature to dissolve and to expel dead, useless, and diseased tissue. I even gave rules how to treat these cold abscesses, and recommended aspiration and subsequent filling with iodoform glycerin. I believed that both remedies, congestion hyperæmia and iodoform, happily supported each other, in so far as the former led partially to cicatrization, partially to cold abscesses of such foci as could not be reached by the iodoform. As regards the change into cold abscesses, we could combat them more successfully with iodoform than any other phenomenon of tuberculosis. But I have later concluded that the production of large cold abscesses by congestion hyperæmia in the majority of cases doubtlessly means a turn for the worse of the disease, for they appear so frequently and grow so rapidly that one cannot master them, and, furthermore, the combination of congestion hyperæmia and iodoform therapy is unfortunate and aimless.

The other harmful experience we made was the development of large granulating masses, which as a rule appeared in open ulcers and fistulæ of open joint tuberculosis, but sometimes also in subcutaneous covered ones, finally breaking these through. Occasionally I saw after a continuance of the remedy the desired shrinking and cicatrization of the excessive granulation; often, however, it progressed unhindered, and compelled us to stop the treatment, and to replace it by surgical operations. The worst result, however, was that in open joint tuberculosis—evidently under the influence of the remedy—the most violent, acute inflammations developed, such as we know become associated with chronic œdemata. I then had to report hot abscesses, lymphangitis, adenitis, erysipelas, and erysipeloid affections

of the skin, even a case of suppuration of the ankle-joint with a fatal result from sepsis. However, these serious complications were observed only in grave forms of tuberculosis. I saw them only in connection with large tuberculous ulcers, and especially in large joint cavities which were filled with pus, and which communicated with the outside by means of a sinus.

As a rule, errors in the technique of bandaging or too free use of the limbs, which was permitted by us as much as the pain allowed, could be demonstrated. But on considering the cases objectively we could not get rid of the conviction that the applied remedy was to blame. I therefore then advised that all the cases of open joint tuberculosis which were to be treated with congestion hyperæmia should be dressed aseptically, and permitted the use of the limbs either not at all, or to a very limited extent. I furthermore reported that even in cases running a favourable course congestion hyperæmia alone did not lead to our goal. Frequently we had to make use of conservative methods, extension bandages, plaster-of-Paris casts, iodoform injections, etc., or even to resort to more or less important operations.

Now, it seems reasonable to assume that if the same remedy once is followed by the most brilliant success, while another time it leads to a grave failure, it was correctly applied in the first case, and falsely in the second. This conclusion I, too, have drawn from my experience. It struck me as significant that the congestion hyperæmia was followed by the best results in tuberculosis of the shoulder-joint, where it can be applied only with comparative difficulty, and in a few cases of tuberculosis of the testes. As I have already said, in both the locality does not permit a prolonged application of the hyperæmia. At most the latter can be used twelve hours daily, because the place of constriction cannot be changed, thus, if applied for too prolonged a time, producing disagreeable phenomena of pressure. On comparing the cases, which were undertaken at a later date, it struck me forcibly that the very cases treated in the beginning (in the year 1891) showed the best results. At that time I applied congestion hyperæmia but a few hours daily.

I have furthermore observed that, after prolonged application of the congestion hyperæmia, œdema becomes prominent, and the hyperæmia becomes less apparent. Thus, a chronic œdema had formed, which was positively harmful for the production of prolonged hyperæmia. I therefore proceeded in this way: I applied prolonged congestion hyperæmia only for a few days, then ordered intermissions, which were lengthened in proportion to the improvement of the cases, until finally the treatment was applied only one hour daily.

I also demonstrated that that form of congestion hyperæmia which so influenced the circulation that intense lividity and diminution of the temperature of the skin were produced in the corresponding part, and, further, that congestion hyperæmia which leads to pain and real inconvenience, are noxious. I therefore made the rules:

1. Congestion hyperæmia must never produce pain; otherwise it is either improperly applied or the case is not suited for this agent, and must be treated in a different manner.

2. The congestion hyperæmia must not be cold; it must not reduce the temperature of the skin to such an extent that it feels colder than the skin of the other extremity. It is indicated in that form of tuberculosis where the congestion hyperæmia, on the contrary, can be so applied that the temperature of the skin becomes elevated, and the locality exposed to the remedy gives the impression of an acute inflammation.

After the establishment of these rules, the dangerous complications, the grave acute inflammations, disappeared. But while the first rule can be easily followed, for we need only tell the patient to either inform us or himself loosen the bandage as soon as he feels the least pain or paræsthesia in the limb, the second rule is executed only with great difficulty. While it is easy to produce hot congestion hyperæmia in acutely or subacutely inflamed limbs, this proves a hard task in chronic tuberculosis, and what is more difficult still is to maintain the stasis after it has once been produced. Thus, the cases of joint tuberculosis treated with congestion hyperæmia required great care, and though the results improved, the formation of large cold abscesses did not cease.

We then more and more reduced the duration of the daily applied congestion hyperæmia. We were especially influenced

in this by Nötzel's above-mentioned contribution, in which it was experimentally proved that the chronic œdema which develops after prolonged congestion hyperæmia is just as harmful to the course of infectious diseases as the changes due to acute stasis are useful. In shortening the time of application of the remedy, I followed partially this plan: For the first few days congestion hyperæmia is instituted seven to twelve hours daily until the painfulness of the joints is considerably diminished. Then the time is reduced one-half, and gradually reduced still more, until after a few weeks or months the congestion hyperæmia is applied but one hour daily. As an example of this method of procedure, I cite the following two cases:

1. A child, seven years old, of a tubercular family, commenced to suffer in June, 1899, from pain in the right wrist-joint, which gradually increased, until in the winter of the same year the joint became swollen and stiff. Passive motions and massage undertaken by a physician aggravated the trouble.

March 20, 1900, I found the right wrist-joint evenly swollen, having a circumference 1½ centimetres larger than the left joint. Flexion and extension were practically suspended, supination somewhat limited. The fingers were fairly movable. The right forearm was atrophied. The joint was sensitive to pressure in two places. Fluoroscopy showed confluent carpal bones to such a degree that their outlines could not be recognized.

From March 20 to October 1, 1900, I applied congestion hyperæmia seven to twelve hours daily, with repeated intermissions of eight days. During the time the bandage was removed the limb was kept in an elevated position several hours.

Hyperæmia was continued from two to three hours daily from October, 1900, to March, 1901; then the treatment was discontinued. The joint improved rapidly, especially as far as mobility and pain were concerned. However, in October, 1900, swelling was present about as much as before, and examination with the Röntgen rays showed still a confluence of the carpal bones, though a brightening of the picture could be noticed.

March 8, 1902, I examined the child for the last time. I found full mobility of the right wrist-joint and full function without any limitation. Measurement showed that the circumference of both joints was alike. The child used the right arm again more than the left one, for which reason the previously established atrophy of the right forearm had not only disappeared, but even had a circumference at the thickest place exceeding by ½ centimetre that of the left arm. The child used its hand throughout the entire treatment—at the beginning only as much as the pain permitted.

A Röntgen picture taken March 18, 1902, showed absolutely normal bones.

2. A child, four years old, of a tubercular family, was attacked by tuberculosis of the left wrist-joint in the winter of 1899. Several cold abscesses developed, which were incised by a physician.

I saw the child July 12, 1901, and noted the following condition: The left wrist-joint is fusiformly swollen; on the back of the hand is an ulcer about 2 centimetres in diameter, and several sinuses leading to rough

bones. The hand hangs in flexed contraction and is subluxated ; motions are considerably limited.

Congestion hyperæmia was applied from eight to twelve hours daily from July 12, 1901, to April 1, 1902, with numerous intermissions of one to several days' duration. From April 1 to August 23, 1902, congestion hyperæmia was applied one hour daily. The disease improved slowly, but a successive progress could be noticed.

August 23, 1902, treatment was discontinued because it appeared that healing was complete. I made the following note : Hand is slightly subluxated ; wrist-joint no longer swollen. Sinuses and ulcers have firmly cicatrized. The wrist-joint, in spite of the subluxation, permits fully all motions. The child uses its left hand just as well as the right one. It has also used it during the treatment as well as it could. The Röntgen picture taken July 12, 1901, shows weak and blurred outlines of the carpal bones ; that taken January 7, 1902, shows plainer outlines. All other bones of the hand and forearm were very much atrophied. The Röntgen picture taken August 23, 1902, shows sharp outlines of bones, but such considerable destruction in the carpal and metacarpal bones that one is obliged to wonder at the good function.

With this procedure œdema was found only at first. Its disappearance was caused by high posture of the limb during the intermissions.

I have scarcely seen cold abscesses since applying the remedy by this method ; at least, they did not appear any oftener than is usually observed in tuberculous patients. But a prolonged observation has taught me that the short congestion hyperæmia now in use by us still favours softening of tuberculous masses and the formation of cold abscesses. But these abscesses do not grow with such surprising rapidity as those following prolonged congestion hyperæmia ; they are easy to treat, and do not interfere with the final success of the treatment.

The results of the described treatment were quite satisfactory. However, even this method of application is too complicated for general practical use, and we now almost exclusively make use of a method employed by Tilmann in the Greifswald Surgical Polyclinic, and with which he obtained excellent results in the outdoor treatment of tuberculous joints. He applies congestion hyperæmia only one hour daily in a manner described on p. 67 (see Fig. 8). For this period it is permissible to allow the hyperæmia to strongly affect the limb, but the bandage must not be applied tight enough to cause pain or paræsthesia in the treated extremity. Also, I do not consider the appearance of the above-described vermilion spots desirable. However, the hyperæmia must be intense. Demonstrable œdema does not

occur in the short period of one hour, but there is a decided swelling of the treated part of the limb. The parts situated peripherally from the affected place are not bandaged, and thus the method is still more simplified when compared with the previous one. It is also not necessary that the congestion bandage be applied closely above the affected joint, but can safely be put—for instance, in tuberculosis of the wrist or ankle joint—around the upper arm or thigh whenever there seems an indication that this is desirable. But this method, too, we do not employ in all cases. We observed that there are obstinate tuberculous lesions which require from the beginning congestion hyperæmia of from two to three hours daily. For the past few years we have not applied the bandage for a longer time than that.

If it prove difficult to produce intense hyperæmia in a tuberculous joint, we first administer a prolonged hot-water bath, after which the bandage usually induces a more decided hyperæmia.

With this form of application of congestion hyperæmia in tuberculosis, I believe the objection which could be made previously, that it is a difficult, and in the hands of the inexperienced, dangerous, treatment is conclusively overcome. I recommend it, therefore, for use by the general practitioner, especially since this short application is followed by as good results as those of longer application. To prove this I cite the following case :

3. A labourer, twenty-three years old, suffered for four years from a tuberculous inflammation of the right foot. Three weeks prior to admission he was confined to bed, because the right foot caused severe pain whenever he tried to press on it. Pain also occurred spontaneously, so that the patient frequently could not sleep at night.

On admission, April 1, 1902, the right ankle-joint was irregularly swollen. Its circumference exceeded that of the other joint by 9 centimetres. Movements were very painful, and possible only to a slight extent. The patient could walk lamely and with pain by the aid of two sticks. The joint was everywhere sensitive to pressure.

The region of Chopart's joint is swollen, the talo-navicular joint very sensitive even to the least pressure. In front of the external malleolus is found a soft, fluctuating swelling.

The Röntgen picture shows enormous destruction of the talus, great destruction on the ankle-joint surface, periosteal granulations in the calcaneus, and pronounced atrophy of all bones of the foot and leg.

April 8, 1902, congestion hyperæmia was applied one hour, and this treatment repeated daily, which rapidly relieved the pain and increased the mobility of the affected foot. The soft swelling in front of the external malleolus developed into a cold abscess, which was incised on April 22

under Schleich's infiltration anæsthesia. About a teaspoonful of pus was evacuated. Congestion hyperæmia was continued.

June 10, at the opening of the sinus, the point of a sequestrum was noticed. This was extracted. It was the size of half a white bean, and was strongly carious. June 11 and 17 small sequestra were expelled.

August 5 the affected joints everywhere became tough and hard. Bright red strong granulations sprang from the sinus in front of the malleolus, but little pus was being excreted from it. There was no pain on pressure or movement. As other sequestra were suspected, the sinus was divided to the extent of 3 centimetres under Schleich's infiltration anæsthesia, and a sequestrum as big as a pea and four smaller ones were removed with a sharp spoon. The wound was covered with aseptic gauze. The first dressing remained *in situ* eight days. August 14 another small sequestrum was expelled from the sinus. August 22 the sinus was firmly closed. The patient is able to walk without stick or pain. Mobility of the ankle-joint is present to a moderate degree. The circumference has diminished 5 centimetres.

As long as the sinuses remained open the patient was ordered to remain in bed, but as soon as the pain had disappeared had to walk daily about fifty paces.

It occasionally happens that sequestra are spontaneously expelled (I observed this in two cases); in other instances they have to be removed by a slight operation after the healing or considerable improvement of the tuberculosis. This is, however, but rarely necessary. More frequently the squeezing or suction of cold abscesses with the cupping-glass, as practised by us, sets free the sequestra. Evidently the tuberculous sequestra heal, as we have observed in orthopædic resections, and probably they are occasionally resorbed because of their porosity and the dissolving effect of congestion hyperæmia.[1]

After this historic introduction, I will depict once more the method of congestion hyperæmia in tuberculosis in its present mode of application. I know that I repeat myself; but I also know that this is necessary, as the method has plainly been wrongly employed. For otherwise it would not be possible for our successes to be so greatly different from those of other surgeons. Furthermore, it would be impossible that such large numbers of tuberculous patients would be mutilated by resection, while our own simple method, as is shown by our results—at least, as regards the wrist, elbow, ankle, and shoulder joints—makes the opera-

[1] For this reason Riedel is greatly in error in drawing the conclusion, from the frequent occurrence of sequestra in tuberculous joints, that this event proves the impossibility of successful conservative treatment, and shows the necessity for resection (Riedel, *Centralbl. f. Chir.*, 1893, Nos. 7 and 8).

tion almost entirely unnecessary ; and this applies even to amputation for many cases in which the conservative operation of resection is no longer possible.

A pliable, soft rubber bandage is applied above the tuberculous joint, in several turns, so firmly that in the peripheral part, and therefore also in the diseased focus, an intense venous hyperæmia develops. *Under no circumstances must the bandage produce any pain ;* on the contrary, it must have the effect of relieving pain. It implies a false conception of the method, when numerous physicians apply the bandage so firmly that it produces paræsthesia, painful sensations, and *intense* lividity. The extremity treated must always remain warm, and the pulse must be plainly felt peripherally from the bandage. We no longer employ the previously practised bandaging of the healthy part of the limb up to the diseased joint. The method, therefore, is simplicity itself. In tuberculosis the bandage is worn from one to three hours daily. If it be applied longer, large cold abscesses frequently develop, which finally cannot be controlled, and spoil the result. In tuberculosis chronic œdema of the affected joint should be avoided. If it occurs, it must be combated by elevated posture during the intermissions.

In open tuberculosis the dressing is either removed or loosely applied while the rubber bandage is applied ; otherwise the constricting dressing prevents the development of sufficient hyperæmia. As a rule, I place the parts covered with sinuses and ulcers on sterile cotton.

I do not make use of complicated dressings in open tuberculosis ; especially do I avoid antiseptics. *Tamponade is harmful ;* it is never employed. Frequently enough cold abscesses develop under congestion hyperæmia. I do not treat them any longer with iodoform, but make small incisions and squeeze them out. This small operation is executed under the strictest aseptic precautions. If it is believed that the rules of asepsis can be disregarded in the incision of the cold abscesses, because of the ability of congestion hyperæmia to suppress all kinds of fresh infections, which will be described later on, it infers a crude misconception of my views and prescriptions. I would not emphasize this if these views had not been expressed by many physi-

cians who have visited the clinic at Bonn. The small operation should always be performed under local anæsthesia; as a rule, the ethyl chloride spray suffices. The physician should be very careful to institute even the smallest operative procedures painlessly. Local anæsthesia robs every painful operation of the feature of cruelty, and makes the minor surgery of the general practitioner very popular.

Of late we make use of cupping-glasses and similar suction apparatus to suck pus and cheesy granulation masses from the small incisions and sinuses. This method is extraordinarily effective, and frequently produces rapid desiccation of the cold abscess or the sinus. This will be described in this chapter in detail.

If the cupping-glass is not made use of, care must be taken to prevent gluing of the small incision of the abscess. The pus, if need be, must be squeezed out as soon as it has reaccumulated.

I abstain from more extensive surgical operations, especially the useless curetting of the granulations with the sharp spoon, which only leads to secondary infection. All explorations of sinuses with probes are to be avoided. *The cold abscesses must be early recognized and early incised.* It is better to make an incision in a fluctuating or pseudo-fluctuating place, without finding an abscess, than fail to recognize one and permit it to become too large. As a rule, these abscesses declare themselves by painfulness and increased phenomena of inflammation—that is to say, by an apparent turn for the worse of the disease.

I make no distinction between closed and open tuberculosis, and treat all cases at first conservatively, unless there exist special contra-indications. I consider as contra-indications: Incipient amyloid degeneration and grave phthisis pulmonum, which require amputation; very large cold abscesses, filling the entire cavity of the joint, which, however, occur but rarely, and almost exclusively in the knee-joint; and faulty positions of the joints, which, at best, after healing would give a worse result than the operative treatment. This is specially applicable to the knee-joint.

I believe that in the treatment of tuberculosis of the joints there is no more dangerous teaching than the academic schematic division into those to be treated conservatively

by resection and by amputation; for I have seen that the first, in spite of careful conservative treatment instituted in the beginning, occasionally progress undisturbed, and the last heal with surprising function, such as could not have been imagined possible with the apparently enormous anatomical destruction of all parts forming the joint.

A similar relation exists between the joint tuberculosis of children, adults, and old people respectively, in spite of the fundamental difference. I do not heed it, and treat children, adults, and old people in a like conservative manner; for I have often seen grave open tuberculosis greatly improve, and even heal, in decrepit old people.

I also consider the rule of abandoning conservative treatment as soon as the trouble becomes aggravated erroneous—at least, as far as the application of congestion hyperæmia is concerned. For what is aggravation? With congestion hyperæmia the appearance of a cold abscess appears as such. It frequently produces violent pains and other phenomena of inflammation, and yet it is only a necessary phase in the course of tuberculosis.

Not infrequently the treatment is followed by one cold abscess after another. Here careful attention has to be continually exercised, and each new abscess must be incised and squeezed out, or, better still, sucked out with cupping-glasses. The congestion hyperæmia, however, is not interrupted.

At the International Congress of Surgeons at Brussels, Quervin and Garré have expressed their hesitation in incising the cold abscesses. They expressed the fear that the patients with open tuberculosis would be easily attacked by secondary infection, and become a danger as regards infection to their relatives. The first I have feared for a long time, and have often expressed it. It has been contradicted long ago by our wide experience. Undoubtedly, the useless curetting of tuberculous granulations and other imperfect "choppings" should be avoided, otherwise there is danger of secondary infection.

It is more difficult to disprove the assertion that tuberculosis with incised abscesses represents a source of infection. Klapp, however, proved that the secretion from sinuses treated with cupping-glasses is very little infectious. Guinea-

pigs into whose peritoneal cavity he deposited the contents of the cupping-glasses remained alive.

I have abandoned the iodoform treatment in combination with congestion hyperæmia, because the combination of these two agents has given me no good results. I make use of iodoform only in hydrops tuberculosus and in large cold abscess filling the entire joint cavity, in which congestion hyperæmia is not indicated. The latter becomes applicable when the effusion has disappeared by the iodoform treatment.

I also generally refrain from immobilizing the affected joints, although it has proved itself a tried and excellent remedy. It has the great disadvantage that it favours stiffening. I purposed, however, to attain mobile and well-functioning joints, and I consider it a harmful result of a tiresome, extended conservative treatment if it ends with the annihilation of as physiologically important an apparatus as a joint. Congestion hyperæmia, as long experience has taught me, enables us to dispense with immobilization. For this reason I permit the use of the affected wrist, elbow and shoulder joints for the execution of the small everyday manipulations, as much as the pain permits—nay, I even permit careful active and passive movements. One should carefully avoid stiffening of the healthy fingers in tuberculosis of the wrist by this agent. The relief of pain which rapidly appears after the institution of congestion hyperæmia permits these measures.

I have been entirely misunderstood, however, for it has been asserted that I treat tuberculosis of the joints with gymnastics. I do not think of such a thing; my whole treatment, on the contrary, is characterized by care and gentleness from beginning to end.

The advice of the excellent and ingenious Liverpool orthopædic surgeon Thomas, to watch in the wrist the possibility of the dorsal rather than volar flexion, so little observed in Germany, should be taken to heart. The simple experiment convinces anyone at once of the correctness of this advice. The normal hand prehends in dorsal flexion more strongly and more skilfully than in volar flexion. The reasons for this fact are so palpable that we need not enlarge further upon them.

I make an exception in most knee and ankle joints. Here we have to take into account the danger that the diseased and soft bones will assume faulty positions under the weight of the body (genu valgum, flat-foot, etc.). For this reason the patients are given a plaster-of-Paris bandage which is cut in two halves, so that it can be removed, or, if the patients are well-to-do, they are given release appliances. These are worn as soon as the patient gets up and makes use of the leg; but as soon as the patient lies down, the bandage or appliance is removed, and passive and active movements are methodically practised to a degree permitted by the painfulness.

Whoever desires to make use of Hessing's and similar apparatus[1] can very well combine with them congestion hyperæmia. I permit walking in the bandage only gradually if the patients have become weakened through the disease. At first they make use of walking-chairs or crutches, then sticks, finally making unaided steps only if it is possible without pain.

Patients with tuberculosis of the joints must take particular care to avoid injuries to the joints, because these are regularly followed by aggravation of the disease. Children especially, suffering from tuberculosis of the knee and ankle, must not be permitted to fall.

The gravest forms of tuberculosis of the foot are at first treated in bed. In these cases the development of pes equinus must be guarded against partially by tilted hoops or splints. But even in these cases we do not avoid movements.

The rule not to immobilize the joints of the upper extremities is occasionally not observed in special cases (subluxation, extreme painfulness) for a while, as no treatment should be carried out according to a rigid rule. I also make temporary use of extension appliances and similar agents to remove contractions in unfavourable positions. These bandages are never permitted to remain on long enough to lead to severe stiffening.

We make extensive use oft he *dispensary* (*outdoor*) *for treatment of joint tuberculosis*. The hospital, surely, is no

[1] All these apparatus themselves produce congestion hyperæmia in the diseased joints, of which one can easily become convinced. I deem it probable that part of their success is due to this property.

favourable place for the tuberculous. Furthermore, the large hospitals, the University clinics especially, are compelled to change patients rapidly, and cannot utilize their limited space for the treatment of the tuberculous, whose disease runs so chronic a course.

It is also natural that the attending assistant displays but little interest in the tedious, conservative treatment. He prefers to see the bed of the tuberculous occupied by a patient on whom he could operate at once either himself, or in whose operation he could at least participate.

We therefore treat almost all patients coming to us from Bonn and the vicinity in the dispensary. This ambulant treatment is of special importance to the general practitioner. He can order his patients to come to his rooms every day, apply the congestion bandage himself, supervise the right degree of congestion hyperæmia until the patients or their relatives have learned the method. If the people are reliable, he can entrust them with the treatment, and need only control from time to time the course of the disease. He must caution the patients to come back without delay if the affection should take a turn for the worse. As a rule, this is due to cold abscesses, which must be incised and evacuated by suction as soon as possible.

We proceed in the same way in the local (Bonn) polyclinic (dispensary). For the first weeks the congestion hyperæmia bandage is applied under the supervision of the director (chief) of the polyclinic. The patient remains with the applied bandage in the waiting-room for one hour, and is watched to see whether correct congestion hyperæmia develops. Later he or his relatives learn the method. He applies the bandage for the legs himself; for the arms someone else does that, but he states whether the bandage is correctly adjusted.

For children, the relatives accompanying them must apply the bandage several days under supervision of the physician before they are allowed to leave.

We have even given cupping-glasses for the suction of sinuses to reliable people for home treatment, and we have observed that they have been successfully applied.

I could publish a review of the cases of joint tuberculosis which I have treated with congestion hyperæmia. If I were

to quote all the cases which I have treated in Kiel, Greifswald, and Bonn, during the course of more than sixteen years, a considerable number would be reached.

But most of the diseases have not been treated in such a manner as I now consider correct, and a large number have not been treated with congestion hyperæmia alone, but also by means of other conservative measures which we have eventually abandoned as superfluous or harmful, so that the observations are not pure. I also frankly confess that the statistics would show no strikingly favourable results if I had to deal with every case that has ever been treated with congestion hyperæmia. Alongside of brilliant successes it would show also many failures, for we had to learn through a variable experience ; and I repeat what I have earlier said : In none of the numerous diseases for which hyperæmia, and especially congestion hyperæmia, is used with success has the development of a correct technique given us as much labour as in tuberculosis. But we are rewarded by being able to offer the method so perfected that it can be safely placed in the hands of any physician, provided he take the trouble to read through once the description of the technique—a thing that has not been done by many who have employed this remedy ; for otherwise it could not happen, as I have recently heard, that a physician should constrict the bandage so firmly as to develop gangrene of the toes, the physician having replied to the complaint of the patient that he felt pain : "That must be so." In the hands of uneducated, careless, or naturally clumsy people, any remedy, for that matter, is dangerous—for instance, even the plaster-of-Paris dressing.

Another physician acted rather less foolishly : he produced artificial bloodlessness with a v. Esmarch bandage in a child, and maintained it as long as the pain would permit, when he released the bandage ; he taught this method to the parents of the child. He of course did not force the constriction so far that the extremity suffered from nutritional disturbance, and, at least, produced the temporary active hyperæmia following the constriction with which we have some time ago made brief experiments.

I deem it proper to publish a report of the treatment of tuberculous patients according to our latest principles at

Bonn, from April 1, 1903—when my activity there began —until August 1, 1904. I close with August 1, 1904, in order to offer a sufficiently long period of observation, and quote only cases where the treatment was given, whenever needed, for at least nine months. The statistics do not represent large numbers, because in the earlier period the number of our patients with tuberculous joints was fairly small. Now the treatment with the congestion bandage and cupping-glass-like suction apparatus has become so popular that we could produce entirely different numbers, a fact which testifies to the value of the method.

The cases quoted have been treated with the congestion bandage only. If we discount the supporting appliances for walking, for grave disease of the lower extremities, they are pure cases. They also have not been selected, except the cases of tuberculosis of the knee, which we will discuss later. Among them will be found the severest forms of open tuberculosis, as well as incipient—old men as well as children. Only exceptionally can the treatment be interrupted before nine months. In only 13 cases of joint tuberculosis was a cure effected in less time—6 wrist, 4 elbow, 1 ankle, and 2 knee joints. Naturally, a good many patients have lost patience, remained away, or sought aid elsewhere, and submitted to operative procedures.

In the following cases, which have kept up the treatment for at least nine months, Dr. Schwalbe has made a classification of the patients. It is he to whom I am indebted[1] for the arrangement. I myself have also controlled the result of the treatment in almost all cases.

1. *Tuberculosis of the Wrist.*—Seventeen cases were treated, 4 of which at the very beginning had sinuses and ulcers. In 5 cases abscesses had to be incised during the treatment. Fifteen cases got well, all with satisfactory (3 with complete) mobility without any limitation, and this in spite of grave anatomical destruction, subluxation position, and complete stiffening of fingers in some cases. Two cases were improved, one with sinuses, the other an intense form of tuberculosis of the wrist-joint, in which incisions for cold abscesses had to be repeatedly made. The average duration of treatment was twelve months.

[1] The statistics were compiled at the end of August, 1905.

2. *Tuberculosis of the Elbow.*—Eleven cases were treated ; 5 had sinuses when first seen. In 8 cases abscesses had to be incised. Eight cases were cured, 2 of which had sinuses. Entirely normal mobility was obtained in none, but in all a satisfactory degree was achieved. The worst case had a range of motion of 50° to 115°. This case will, in all probability, improve still more in the future. Three cases with sinuses were improved. The average length of treatment was nine months.

3. *Tuberculosis of the Foot* (Tuberculosis of the Tibiotarsal, Chopart's, Lisfranc's joint, or several of these joints at the same time).—Thirteen cases were treated, 8 of which came with sinuses. Incision of abscesses during the treatment had to be performed in 6 cases. Eight cases—4 of which were with sinuses—were cured, 3 improved, 1 did not improve, 1 was amputated elsewhere. The average duration of treatment was ten months. Complete mobility was obtained in 3 of the cured cases, satisfactory mobility in the remainder.

4. *Tuberculosis of the Knee-Joint.*—Five cases were treated —1 with sinus, and 2 incipient. Three were cured—2 with complete mobility, 1 with stiffening in good position. Two cases improved ; both became very stiff.

In 8 additional cases resection was performed after a short trial with congestion hyperæmia.

5. *Tuberculosis of the Shoulder-Joint.*—One case, which healed with perfect mobility.

In the above review the large number of resections for tuberculosis of the knee-joint is specially striking. While we made no resection for tuberculosis of any other joint, 8 out of 13 cases of tuberculosis of the knee-joint were treated by resection. The reason for this is : Since I have treated tuberculosis with hyperæmia, I have always had the worst results with the knee-joint, especially when fungus of the capsule was established, for reasons which I could not explain. Even in healed tuberculosis of the knee-joints the function left much to be desired ; they became stiff in faulty position. *But a good function is to me the principal aim of conservative treatment.* If I see that function, at least as well if not better than that obtained by conservative treatment, can be achieved by operation, which is a much more rapid

means, I do not waste time with tedious conservative remedies.

In almost all other cases of joint tuberculosis, where treatment with congestion hyperæmia is applicable, we have achieved, after healing, magnificent functional results, which could not be produced by even the most sparing operation. I have among my results a large number of cases where even the most skilful and careful diagnostician, on comparing the two symmetric joints, could not tell which of the two had been affected with tuberculosis. Proof that lasting results are obtained with congestion hyperæmia is furnished by the following three cases from the years 1891 and 1892 :

4. An eight-year-old boy, two years previous to his admission to the surgical clinic at Kiel, became affected with tuberculosis of the knee-joint, which had been treated with sea-baths and leather splints with but temporary success. On admission was found a tumor albus of the left knee-joint, and subluxation of the leg posteriorly, and slight contraction in flexion. Pain was slight, but the patient was unable to walk. I first treated the diseased knee with iodoform injections without any success, and from November 29, 1891, to January 25, 1892, also without success.

From May 14 to June 27, 1892, prolonged congestion hyperæmia was applied. Then this agent was applied during the night only, and finally only one hour daily. After this the affection improved. Now, after ten years, the young man, who has chosen a business career, informs me that both knees are equally mobile, large, and strong, and that he can stand and walk all day long, halting with the left leg only a little after extended marching tours.

5. I treated in 1892 in Kiel a seventeen-year-old tailor apprentice, who for two years had suffered from tuberculosis of the right wrist-joint. I found a fusiform swelling of the right wrist-joint. Rotation and extension were entirely suspended, flexion possible only to a small degree. On each attempt at motion great pain was produced. The hand was useless.

Congestion hyperæmia was applied continually from June 15 to August 25, 1892, then up to October 24 at night only. I cannot now determine for how long after that he used the remedy for an hour at a time.

The father of the patient informs me ten years later that the right hand remained somewhat smaller and the right arm somewhat thinner than the left. The disease itself, however, has so healed that his son, who has abandoned tailoring and has become a stableman, can do the hardest work with the cured hand without injury. He has the full use of his hand.

6. An eleven-year-old girl was afflicted with tuberculosis of the elbow-joint. The right elbow-joint was fusiformly swollen, and was fixed at a right angle. Motions were almost suspended. The joint was sensitive to pressure. Congestion hyperæmia (prolonged) was applied from March 15 to April 26, 1892, and nightly from this date to June 26, 1892. In the last two months the joint was carefully massaged[1] and passively moved

[1] I have made use of massage for awhile in tuberculous joints which were treated with congestion hyperæmia. I have abandoned it for such cases, but, as already mentioned, have retained it for other articular affections.

during the day. June 27 the child was discharged. The congestion hyperæmia was continued at home during the night and later one hour daily.

The girl is now grown up. Her joint is movable to the greatest extent, and can be used for work. Now a sensation of stiffness in the right arm appears only after severe exertion; it soon disappears after a short application of congestion hyperæmia.

The following two observations show that ideal healing of tuberculosis occurs also in other than "mild" cases:

7. I treated in 1893 and 1894 a boy, then ten years old, for grave, open tuberculosis of the knee-joint which had existed three and a half years. In 1903 the young man was ordered to the recruiting-station for the performance of military duty. His statement that he had suffered from tuberculosis of the knee-joint was not believed, because of complete healing and in spite of the scars. It required a certificate from me that the boy had undoubtedly suffered from a severe fistulous tuberculosis of the knee before he was liberated from his military obligation.

8. A young man, twenty-one years old, was treated in the clinic at Bonn in 1904 for tuberculosis of the ankle-joint by means of congestion hyperæmia. The left ankle-joint was fusiformly swollen and almost immobile. It measured at different places 1½ to 5½ centimetres more than the right joint. A cold abscess was incised. The patient was discharged cured August 1, 1904. The circumference of both joints was the same; the cold abscess and its sinus had healed. The left ankle-joint was movable in every direction. In the spring of 1905 he was accepted for army service, but, presumably, will be relieved from duty on a certificate from the clinic.

The best successes of congestion hyperæmia were observed in tuberculosis of the wrist, elbow, and ankle joints.

Of the cases above mentioned which had undergone treatment of at least nine months' duration, the percentage of those that were healed was as follows:

Wrist-joint	.. .. ..	88·0 per cent.
Elbow-joint	.. .. ..	72·7 ,,
Ankle-joint	.. .. ..	61·5 ,,

And I reiterate explicitly that these cases have not been selected, as is demonstrated by the large number of patients with open tuberculosis, and that throughout no resection has been performed.

Certainly these small statistics, like all others, suffer from deficiencies, for it is difficult to say what healing is in tuberculosis, and because we do not know whether in this or that case a recrudescence is going to take place. But against this no single method of treatment offers protection, and cures which have remained such over a decennium have taught me that congestion hyperæmia really leads to permanent results. Relapses are again treated with congestion hyperæmia

Occasionally the objective changes of the joint do not keep pace with the improvement of function and diminution of pain. The swelling especially sometimes remains fully, while the limbs are utilized without pain, there being, however, this difference, that it is much harder than it was at the onset. The return to the normal contour of the joint therefore proceeds gradually.

The hardening of soft tubercular granulations is the best sign of healing.

But in addition to these slowly healing cases, I have seen tuberculosis which improved under congestion hyperæmia with incredible rapidity, so that they early lost the character of a tuberculous affection. The cases are so striking that I always hesitated to classify them as tubercular, assuming that they were wrongly diagnosed, and that a joint afflicted with osteomyelitis, gonorrhœa, etc., ran a chronic course, which gave cause for it being looked upon as tuberculous. Nevertheless, I have now seen a total of four or five cases where the correctness of the diagnosis left no doubt.

All these cases which quickly lose their tubercular character under the influence of congestion hyperæmia are, without exception, characterized by the enormous reaction following the application of the congestion bandage, frequently even when the constriction is slight. The diseased joint becomes fiery red and hot to the touch. Occasionally blisters and eczema make their appearance, so that anyone who saw the extremity without knowing of the presence of the congestion bandage would conclude that we had to deal with a highly acute inflammation. After a few weeks further treatment can be discontinued; the tuberculosis heals by itself with formation of stone-hard connective tissue in the diseased joint. It is regrettable that these cases are very rare.

Finally, I must mention the observations made by others with hyperæmia produced by means of the rubber bandage. The literature on the subject, in spite of the fact that my first contribution on this method is now fifteen years old, is so small that it is not worth while discussing it in detail. Relatively good results are reported by Henle[1]

[1] Henle, "Die Beh. d. tub. Gelenkerkrankungen u. d. kalten Abscesse an d. chir. Klinik in Breslau in d. Jahren 1890-1896" (*Beiträge z. klin. Chir.*, vol. xx., No. 3)

from the v. Mikulicz clinic, Habs,[1] Manniger,[2] and Kirchhoff.[3] But though in the bibliography little is said, I know that bad results have predominated in the application of congestion hyperæmia in tuberculosis. As a rule the method has been abandoned as dangerous, uncertain, or ineffective.

This does not in the least discourage me. I know very well that it is not only dishonest, but also stupid, to attempt to hold a post recognized as doomed. But I do not yield here one step ; on the contrary, I take one forward, and assert that the largest number of the failures is to be ascribed, not to the method, but to its application, as we shall soon see. And while I formerly claimed for congestion hyperæmia that it was a good method of treatment for tuberculosis of joints, which was demanding for it a prominent place alongside the other methods, I now declare it to be the best conservative agent at our command, which with the least risks simply and cheaply achieves results, especially as far as function of the diseased joints is concerned, to which none of the other methods of treatment can even approximately approach. It must be added that at the same time it is the most agreeable of them all, because it removes the pains from the patient without causing him new ones, in addition to leaving him the most perfect use of his limb.

By this I do not mean to say that the mutilating operations have been done away with ; for even this remedy frequently leaves us in the lurch : it is by no means infallible, especially as it is a pronouncedly individual remedy, for the main question is always centred in the kind of blood the patient places at our disposal with which to combat the disease. But I am firmly convinced that with progressive experience in this domain, and with the better development of technique for each individual case, results will be still more favourable, and operations pushed into the background.

The remarkable difference between the results of other physicians and mine demands an explanation. First of all, most of them have applied a faulty technique. I know from

[1] Habs, "Über die Bier'sche Stauung" (*Münch. Med. Wochenschrift*, 1903, No. 22).

[2] Manniger, "Die Heilung lokaler Infektionen mittels Hyperämie" (*Würzburger Abhandlungen*, vol. vi., No. 6).

[3] Kirchhoff, "Über Beh. d. Tub. nach Bier," Inaug. Diss., Munich, 1906.

oral reports and short written communications, which repudiate congestion hyperæmia, that many have abandoned the remedy because of its too great painfulness. *They have certainly applied it absolutely wrongly, and have entirely misunderstood its purpose.* I need not again repeat the proofs for this. Another reason is to be found in this, that at first, owing to faulty technique, the perfection of which demands much time and labour, aggravation of the tuberculosis was really produced by the congestion hyperæmia, the large rapidly growing abscesses being the most frequent and annoying indication of excessively long application of the congestion hyperæmia.

To this must be added the fact that most surgeons look upon the occurrence of cold abscesses as an aggravation, even when they develop gradually. I myself at first wrongly advised as follows: to prevent as much as possible their opening, to aspirate them, and then to combine the iodoform treatment with congestion hyperæmia. If the abscess opened, resection was deemed necessary, because of the above-mentioned foolish classification of individual cases into such as were to be treated conservatively and by operative procedure. *The cold abscess, however, which develops under congestion hyperæmia by no means represents an aggravation of tuberculosis if it is recognized early and correctly treated.* Nor does the tuberculosis with sinuses represent a contra-indication to conservative treatment. I can affirm that these cases often heal better and more quickly than the dry forms of tuberculosis, which remain closed. Therefore, things have been regarded as an aggravation which are not so.

The third reason for the rejection of congestion hyperæmia in tuberculosis has been observed in that too rapid results have been expected. As already mentioned, I seldom cease the treatment before nine months; frequently I apply it for a longer period. But is not the treatment with other remedies tedious? But we are recompensed for the long duration by better functional results. To this must be added the fact that the greatest number of the tuberculous patients use their diseased extremities during the treatment, an absolutely impossible condition with operative methods.

Recently we have, it seems, made a great step forward in the treatment of tuberculosis with sinuses, and that form which is accompanied by abscesses, by the resumption by Klapp in the Bonn polyclinic of my treatment for tubercular affections with cupping-glasses, which I practised about ten years ago. Klapp has improved the technique and obtained better results. I have already said above that, in the form of tuberculosis under consideration, we suck abscesses and sinuses by means of cupping-glasses, in connection with the bandage, thereby removing the pus and cheesy granulations, while at the same time producing hyperæmia. Klapp has tried—in abscesses and sinuses only—to conduct the treatment exclusively with the cupping-glasses.

This appears to promise success, because, as we have said, the cupping-glass produces hyperæmia in the deep layers. In joints the abscesses and sinuses are always directly over the disease focus, in that respect differing from caries of the spine.

The technique of this treatment is :

The cupping-glasses which are utilized have been described on p. 79 *et seq.* They are the same as used for the treatment of acute superficial inflammation. As the swelling of the tuberculous joints is often not as pronounced as that of acute inflammation, where the removal of the folds and the swelling make the application of the glasses difficult, we must make use of appliances which fit the contours of the body—*e.g.*, with margins, which are not cut in a plane, but hollow, corresponding to the contours of the joints (see Fig. 11, *e*). The latter can be applied where the former would fail to adhere. As a rule, personal skill will adapt the variety of the glasses.

The preparation of the cupping-glasses for use requires special attention. The mechanical cleansing, boiling, and preservation in sublimate (1 : 1,000) has proved best in our hands. This must be specially controlled when their care is left to the nurses. I emphasize this specially to avoid the possibility of dirt and of the danger of transmission of disease, etc.

The preparation is complicated and tedious. But if this treatment bears the test of time and criticism, one will get

used to this, as has been the case with our tiresome aseptic procedures.

It makes no difference whether we have to deal with tuberculosis of the bone, gland, or other organs. Tuberculosis accompanied by the formation of sinuses and abscesses reacts equally favourably to the cupping-glass.

The latter is at first applied three-quarters of an hour daily to all forms of open and fistulous tuberculosis, which have not been treated heretofore. The rule laid down for acute inflammation, that the cupping-glass should be removed for three minutes after it has been applied for five minutes, holds good here also. The patients are given *daily* treatment until the indolent, pale tuberculous granulations become red and hard, and until the immediate vicinity of the sinus becomes hard. It is then time to increase the intervals between the treatments: at first every second, later every third, and finally every eighth day.

If cold abscesses are present, these are opened by an incision, after due aseptic preparation, and immediately sucked out with the cupping-glass. At first the abscess re-forms by the next day. If, however, suction is practised daily until bloody serum only is evacuated, the suppuration soon ceases. As soon as this condition is reached and the granulations become tough and red, longer intervals are instituted.

One must never think that the more one applies the suction-glass the more is achieved. One can occasionally do too much of a good thing, and over-zealousness, as with any other remedy, is harmful here too.

For acute local inflammations, as furuncles, carbuncles, hot abscesses, the suction must be applied so mildly that the patient does not complain, but in tuberculous sinuses and abscesses it may be applied more strongly.

Practically applied, this means for everyone not familiar with this treatment: *In acute inflammation the rubber ball which produces the thinning of the air must show a shallow, in tuberculosis a deeper, depression upon its application.* This treatment, unaided, gives good results in tuberculous sinuses and abscesses. It is better, however, to combine it with hyperæmia induced by a bandage.

In the vicinity of tuberculosis with sinuses which has been treated with the cupping-glass one often sees ulcers, which must be regarded as inoculated tuberculosis. To avoid this, Klapp suggests the following method : After removal of the dressing, and previous to suction, the vicinity is cleansed with benzine, and a large surrounding area is covered with fat (lanolin, vaseline, āā). After suction the first fat is removed with benzine, and fresh applied.

The treatment with the cupping-glass appears to me of great importance, because it does not require as careful a technique as does congestion hyperæmia by bandage. This is evident from the fact that, in my extensive experiments with the cupping-glass, made about ten years ago, I did not attain as good results as Klapp does now, for which reason I rejected this method. The fault, in the first place, was in the too prolonged and too intense application of the cupping-glass without proper intervals. We learnt by experience with the large suction apparatus before described, that at each séance the production of hyperæmia must be interrupted by intervals. The application of this experience to cupping-glasses is what made Klapp more successful.

In this treatment, too, granulations are not curetted, nor do we tamponade, drain, or probe. Incisions, sinuses, and ulcers, are covered only with an aseptic dressing.

Improvement of the tuberculous joint with cupping-glass treatment can be recognized by the hardening of the soft, fungous granulations and by the return of the fusiform swelling to the normal contour. Hofmann[1] has made interesting observations on the effect of the cupping-glass on tuberculous tissue. The histologic examination of granulations, taken before and after suction, showed that the narrow vessels, filled with leucocytes, became diluted under the influence of the cupping-glass : the leucocytes disappeared from them and from the tissue, being practically washed away. The latter, with numerous bacteria, are found in the cupping-glass. It was shown that the leucocytes are drawn with great force into the uppermost strata of the epidermis. Hofmann was able to confirm my view,

[1] Hofmann, "Veränderungen im Granulationsgewebe fistulöser, fungöser Herde durch Hyperämisierung mittels Saugapparate" (*Münch. Med. Wochenschrift*, 1905, No. 39).

gained through clinical observation, that the easily bleeding small vessels become stronger after a few applications of the suction apparatus. He found that the connective-tissue elements of the vascular wall became increased, and that the simple endothelial layer became transformed into several layers. Numerous newly appearing vascular sprouts (germs) show that the suction probably favours the formation of new bloodvessels.

Six years ago I treated a number of cases of open and closed tuberculosis with the large suction apparatus described on p. 92 *et seq.*, and which I made use of in an imperfect manner in the beginning of my experiments with hyperæmia.

If a tuberculous joint is placed in the apparatus, and the air within thinned, enormous hyperæmia and swelling of the affected part occur. Occasionally this is not so pronounced in the first few days, but after the apparatus has been used two to four times it appears in an intense form with great regularity. From the sinuses and ulcers blood-coloured serum and pus flow out, while granulating masses protrude, as if they were sucked out from the deeper layers. In the beginning hæmorrhages frequently take place from sinuses and ulcers, but after repeated use of the apparatus the granulations become more capable of resistance, and do not bleed any more. Daily use of the apparatus produces œdema, which may reach the highest degrees and become chronic—this even though the apparatus be used only every other day.

The effects of the apparatus on the course of tuberculosis, if used daily, were variable. In some cases it produced rapid and striking improvement, in others just as rapid aggravation; on the whole the experience was similar in character to that obtained with excessive congestion hyperæmia—viz., cold abscesses, breaking down and changing into ulcers, granulating masses, and the development of rodent ulcer with undermined, thin margin of the skin, etc., with the only difference that the entire process occurred more rapidly, corresponding with the greater and more energetic effectiveness of the apparatus.

Twice we observed the appearance of acute infection (Cases 11 and 12). On the other hand, we had excellent

results with this agent, even in grave cases. I will cite examples of both :

9. A woman, fifty-one years old, during an attack of vertigo in February, 1901, fell to the floor. A few days later pain appeared in the knee-joint, which became considerably worse, and at last so intense that the patient could only limp with great pain, and the pain frequently kept her awake at night. Admitted February 15, 1902, to the Greifswald surgical clinic.

The left knee-joint is fusiformly swollen, and is 2¼ centimetres larger in circumference than the right. It is fixed in flexion contraction, cannot be extended, and can actively be bent to less than a right angle. On flexing the joint, pseudo-fluctuating swellings appear laterally and below the patella.

Suction apparatus was used twenty minutes daily from February 20 to April 8. A decided hyperæmia appeared only after the third application, and thereafter regularly. Œdema did not form.

March 14 the patient had lost her pain, walked without limping, free from pain, felt perfectly healthy, and could even run. April 9 she was discharged, with the following result : The knee can be fully extended and actively bent to an angle of 70 degrees. The circumference of the left knee at its largest point measures 1 centimetre more than that of the right. The patient can use her knees all day long without any inconvenience.

The next case is an example of a cure of very grave and far-progressed tuberculosis of the joint by hyperæmia with the suction apparatus :

10. A boy, aged thirteen, became affected in August, 1900, with tuberculosis of the left elbow-joint. He was admitted to the surgical clinic (Greifswald) June 12, 1901. There was a fusiform swelling of the left elbow-joint, which had led to cold abscesses. The Röntgen picture showed an apparent sequestrum in the olecranon. The joint was fixed at an angle of 105 degrees. Movements were impossible actively, and but slightly passively.

As we had here to deal with tuberculosis with abscesses, these were incised, curetted, and sutured after the method of Billroth, after being filled with iodoform glycerin. The suspected sequestrum in the olecranon was not found. Healing took place almost by first intention, and the patient was sent back to his family physician for treatment July 12, 1901.

The boy was readmitted February 21, 1902, with a severe tuberculosis of the elbow-joint. The joint was irregularly swollen, and surrounded by a chain of large ulcers, which were covered with spongy, grey granulations, whose skin margins were undermined, and from which sinuses led into the depth. The largest of these ulcers was as big as a five-shilling piece. Ulcers and sinuses suppurated considerably. The probe met rough bone. The skin was so extensively undermined that the probe pushed into a sinus reappeared at the opening of another 7 centimetres distant. The elbow was very sensitive to pressure ; the left upper arm was decidedly atrophic.

The patient was treated with the suction apparatus twenty minutes daily from February 25. The region of the joint became dark blue. Bloody serum, pus, blood, and spongy granulation masses, were drawn from the sinuses. For hours after the application of the apparatus the region of the affected joint was hot to the touch After fourteen days the excretion from sinuses and ulcers greatly diminished, the granulations began to look dark red, the undermined skin began to heal to its basis. Fourteen days later it could be noticed that the previously

soft swelling became hard. May 1 it was established that the sinuses scarcely secreted, the skin had healed everywhere, and that the ulcers were covered with a crust which was left undisturbed. In May, an intermission of two weeks was ordered, after which treatment with the suction apparatus was resumed, and now administered every other day. The patient was discharged August 1, 1902, with the following result: All ulcers and sinuses have healed and are covered with skin; the joint looks smooth, and has lost its spindle form; it feels hard all around. Mobility has not increased. The patient, previous to his discharge, has been taught the use of the congestion bandage, which he is instructed to use one hour daily.

The Röntgen picture offered some interesting points. The one taken on admission of the patient showed the ends of the joint confluent and undeterminable. The bones were very atrophic. With progressive improvement the bones became plainer, and on discharge were rather sharply defined, and showed a darker shadow in the region where the disease had its seat than that of the healthy, distant parts. To judge from the picture, there exists a bony ankylosis of the articular ends; in the soft parts cord-like dark shadows, probably tough connective-tissue bands, which have developed from the granulations, and which cause the joint to appear so hard to the palpating finger.

In contradistinction to these successes, which I could multiply considerably, we have observed considerable aggravation in tuberculosis of the joints under the influence of the suction apparatus. The two worst cases are as follows:

11. A cabinet-maker, fifty-three years old, states that he took ill February 23, 1901, subsequent to a sprain of the right wrist-joint. This became painful and swollen. The symptoms became aggravated, for which reason patient was admitted November 22, 1901.

He suffered from extensive, double-sided pulmonary tuberculosis. The right wrist-joint had a larger circumference of 3½ centimetres than that of the left. It was almost entirely stiff—in fact, so much that the finger-tips at the attempt to make a fist remained 7½ centimetres distant from the palm. Rotation, too, was considerably limited.

The affected limb was treated half an hour twice daily with the suction apparatus from November 24. Decided hyperæmia appeared, and after a few applications also chronic œdema. January 23, 1902, I found, after an improvement in the mobility of the finger and wrist joints, a cold abscess on the ulnar side of the hand, which was aspirated without injection of iodoform. Treatment with the suction apparatus was suspended for a few days, and then resumed. From February 14 the apparatus was used only twenty minutes every other day. February 20 the abscess perforated spontaneously, and as there appeared to exist pus retention, it was incised. A mixed infection occurred with high fever, so that April 23 resection of the wrist-joint had to be performed, and owing to progressive suppuration and phthisis pulmonum the arm was amputated May 27.

12. A boy, three years old, decidedly scrofulous, suffered from grave open tuberculosis of the right wrist-joint. He received daily treatments of twenty minutes' duration with hyperæmia by the suction apparatus from March 10 to March 25, 1902. March 26 developed an acute inflammation of the affected joint with reddening of the skin up to the upper arm, which compelled us to suspend the treatment. The

inflammation disappeared after a few days, but meanwhile the tuberculosis of the wrist-joint made considerable progress. The trouble was aggravated by the appearance of several new ulcers with strong granulations and undermined margins. From June 25 hyperæmia by bandage was instituted, which produced a slow but decided improvement.

For this reason I stated in the first edition of this book :

"Thus, in the treatment with the suction apparatus we have had, alongside of successes, the same failures as we have seen before in prolonged and intense congestion hyperæmia by bandage, and have drawn the conclusion that we have used the suction apparatus too long and too forcibly. After these preliminary experiments, we have reduced its application, so that it does not produce chronic œdema. For this reason I never use it daily, but, depending on the reaction it produces, for twenty minutes every second to fourth day. We take care that it is not used again until all œdema has disappeared. Since this precaution has been observed we have not seen those failures, but our experience with this method is so limited that we cannot pass an opinion on its merits as a therapeutic agent for tuberculosis of the joints. I recommend that for the present the general practitioner use hyperæmia produced by the application of the bandage, and advise against the use of the suction apparatus until further experience concerning the caution with which it has to be applied and its effect can be acquired."

I regret that I have not collected this experience even up to date, as I have failed to institute further experiments in the treatment of joint tuberculosis with the large suction apparatus. The domain in which the treatment by hyperæmia is available is so large that it is beyond the resources of one clinic to thoroughly test everything simultaneously.

In the first edition I described that, just as we proceed now with the cupping-glasses, so also we never produce hyperæmia with the suction apparatus throughout one séance, but always allow intermissions of twenty seconds to one minute after a few minutes' application. According to our latest experience with cupping-glasses, we recommend an increase of the length of these intervals.

Meanwhile Klapp has treated in the Bonn polyclinic cases of spina ventosa with suction apparatus with satisfactory results. The treatment of this disease is still highly deficient. Congestion hyperæmia—at least, in progressed cases—produced little result, iodoform injections and other conservative measures still less. Surgical procedures yielded but moderate results, since they always lead to mutilation of the extremity concerned. Klapp arranged the suction apparatus for these cases very simply. He provided a v. Esmarch glass irrigator at its open end with

a wide para-rubber cuff, which he fastened with leather. The wide cuff enables the child's hand with open spina ventosa to be placed into the vessel without touching the rubber. The wide elastic cuff is bandaged to the arm of the little patient with a rubber bandage. The air is rarefied in the usual manner by means of a suction pump.

At first the apparatus is applied about forty-five minutes daily. With increasing improvement larger intermissions are ordered, until finally the application is made forty-five minutes every eight days.

Cold abscesses are opened by a small incision. Whenever new ones develop during the treatment they must be incised early.

The results of this treatment are excellent. I quote as an example the following case :

13. A child, eight years old, became affected in the spring of 1905 with a spina ventosa of the first metacarpus of the left hand. It entered the Bonn polyclinic May 15. The left dorsum had a cold abscess as large as a dove's egg over the first metacarpus. An incision evacuated a quantity of thin pus. Suction treatment commenced at once, and was given once daily for a month June 22: Temporary intense pain, relieved by incision of a newly formed abscess. Cupping for three consecutive days after this enabled the limitation of the suction treatment to twice a week. July 24: The child looks very well, and has a better appetite than it has had for a long time. The fungous swelling has entirely disappeared. The dorsum of the hand is slender, and is uniformly thick and firm on palpation. The small incision is closed.
The strength of the hand is completely restored.

Treatment of Other Forms of Tuberculosis.

Next to tuberculosis of the joints, it is that of the testes which I have treated most frequently by means of congestion hyperæmia, which is applied in the following manner :

If both testes are diseased, they are firmly drawn downwards, and a soft piece of rubber tubing padded with cotton is placed around the base of the scrotum, and so firmly drawn that it produces intense congestion hyperæmia. The ends of the rubber are closed with a pair of forceps. If only one testis is diseased, it is drawn downwards, while the healthy one is pushed upwards. The rubber constrictor is applied in the same manner. The testes are placed in a spacious suspensory. The constrictor is worn one to three hours daily.

One easily succeeds in this manner in producing an intense congestion hyperæmia in the testicles. I have made good use of it in ulcerating and fistulous cases, and have observed how large ulcers have healed. The agent proved less successful in the tuberculous indurations of the epididymis, found in the beginning of the disease. Cold abscesses are treated by small incision.

In addition, I have treated tuberculosis of the bone, tendon sheaths, skin, subcutaneous cellular tissue, and also lupus of the skin, with congestion hyperæmia. My earlier reports on tuberculosis of tendon sheaths contained but a limited experience. I have observed its considerable improvement, but never complete cure. I therefore gave the advice not to keep up for too long a time the conservative treatment, but to extirpate the tuberculous granulations, as this leads more rapidly to cure, and gives good functional results. I have changed my views on this completely since I have succeeded in obtaining ideal cures, in the fullest sense of the word, in the gravest forms of tendon-sheath tuberculosis by the application of congestion hyperæmia. I now proceed in the following manner : The tuberculous hygroma of the flexor tendons is opened by a small incision above the wrist. The fluid and rice bodies are carefully pressed out from the tuberculous sac of the tendon sheath by sliding movements from the periphery. This must be continued until all the rice bodies are removed, which often requires considerable time. The small wound is provided with an aseptic bandage, and congestion hyperæmia is now instituted for one to two hours daily. Our results have been excellent. I will quote the clinical history of a grave case :

14. A sixteen-year-old college boy suffered for more than a year from tuberculosis of the sheaths of the flexor tendons of the right hand. A few days before coming under my treatment a fine sinus developed above the right wrist, from which a watery liquid was sparingly excreted.

I found this condition : the entire palm was occupied by a ball-like swelling. A second similar swelling had its seat above the ligamentum carpi transversum. Both swellings fluctuated, the fluctuation extending from one to the other Throughout the flexor tendons of the small finger, large, hard nodules could be felt, following the movements when the finger was bent. Similar nodules were felt in the region of the peripheral sheaths of the flexor tendons of the third and fourth finger, and in the palm. The three last fingers were intensely stiffened. Above the wrist was a sinus opening scabbed over. After removing the scab, pressure on the swellings elicited from the sinus serous-pus liquid and rice bodies.

I dilated the sinus and removed a large number of rice bodies and liquid by kneading from the palm. It required several days to produce complete evacuation.

February 20, 1904, I applied a hyperæmia bandage, which was worn one hour daily for something over a year. The disease improved greatly, and was completely cured in the course of one year. The nodules in the tendon sheath of the small finger and in the peripheral tendon sheaths of the third and fourth fingers remained longest.

I examined the young man for the last time August 6, 1905. An uninitiated examiner could scarcely have told which hand had been the one attacked. On careful palpation, only a small swelling could be noticed in the tendons of the fourth and fifth fingers in the region of the second joint. The movements of the hand are perfect. The young man is a skilful and dextrous pianist, and states that in touching the keys with the left hand he has no trouble whatever.

Tuberculous hygromata of the dorsum of the hand are treated in the same way. If they are very small, they are not opened; otherwise they are incised and evacuated by squeezing. After this congestion hyperæmia is applied.

The smaller hygromata are suitable for treatment with the cupping-glass, which must be cut to fit the contour of the dorsum of the hand.

In pure tuberculosis of the bones, I usually remove the focus by operation, if it can be foreseen that the function of the extremities will not be damaged. But, as already mentioned, Klapp has recently made successful use of suction treatment for spina ventosa.

As regards tuberculosis of the glands, that of the cubital gland only is suitable for treatment with congestion hyperæmia. Of course, this form has but little practical value, and I will therefore not discuss it, but will only remark that tuberculous glands treated with congestion hyperæmia are inclined to softening and the formation of cold abscesses—in fact, much more so than the joints. Such tuberculous glands accompanied by abscesses and sinuses are suitable for treatment with the cupping-glass after the abscesses have been excised. Years ago I treated a whole series of such cases, with different results. Of late Klapp has resumed the treatment with better success.

The cupping-glass, too, strikingly softens the open tuberculous gland. In this way glandular masses can be gradually turned into abscesses, and sucked out through sinuses and wounds by incision. I quote the following case, treated by Klapp in the Bonn polyclinic, as an example:

15. A young man entered the Bonn polyclinic January 23, 1905, with a collection of large tuberculous glands, over which was situated a large cold abscess. To give an idea of the size of the entire mass, we state that its level extended outwardly over the ear.

The cold abscess was opened by an incision. A large quantity of pus came away spontaneously, and also immediately upon the application of the cupping-glass.

The abscess became filled again during the next few days, and was sucked daily until bloody-serous liquid came away. After about eight days the abscess had disappeared, the collection of glands was dry. With the fixed intention of attempting further softening of the glands, daily treatment with the cupping-glass was continued.

Soon a decided softening appeared, which was opened and sucked as the first time. The collection of glands, which for a while could be felt diffusely through the abscess, again appeared dry, and each individual gland could be palpated. It was then observed that the collection had become greatly diminished.

The treatment was continued in like manner for five weeks. Softenings appeared several times, and were emptied. Finally, only a flat, diffuse swelling remained.

At the request of the patient, Klapp decided to extirpate what was assumed to be a remaining collection of small glands.

On operation it was found that there were no glands, but that their place was occupied by a hard induration of the size of a finger.

The anatomical examination of the induration was made at the Bonn pathologic institute. The report is:

"In the induration are many tubercles in fibrous degeneration, and a pronounced granulation of the connective tissue between the tubercles and in their immediate vicinity, a fact which certainly must be attributed to a healing process. On the whole, the tuberculous granulation tissue gave the impression that it contained fewer cells than are usually found. This deduction was based on the observation of pronounced new formation of connective tissue in the interior of the granulation masses.

"The small vessels are everywhere dilated. There are also a limited number of small hæmorrhages. The larger arteries show granulated intima up to considerable narrowing of the lumen—that is to say, a process accepted as a healing reaction of tuberculosis.

"The sinus of the skin offers, *mutatis mutandis*, the same picture of fibrous, indurated, tuberculous granulation. Necrosis is found, but to a limited degree, throughout the entire preparation."

Klapp has had much better success with the cupping-glass treatment of suppurative tuberculosis with and without sinuses of the gland than I some time ago. The reason for this is now clear to me. I permitted the cupping-glasses to remain on longer at a time, and made use of large instruments, because I expected from them the most intense hyperæmia and better effects. But we learnt by experience with the large suction apparatus that intense, prolonged hyperæmia in one séance without intermission frequently aggravates the tuberculosis. Klapp applied this experience also to the treatment with cupping-glasses. As in the case of joints with sinuses, he commenced with séances of forty-five minutes'

duration, allowing the cupping-glass to remain *in situ* five minutes, taking it off for three minutes, applying it again for five minutes, etc. Furthermore, the smaller cupping-glasses are better than my former large ones, which I utilized for the application to a whole side of the neck ; for the smaller instrument draws out pus and necrotic masses more profusely through the sinuses. This is no doubt due, as was shown by Rube, to the rarefying of air in the smaller appliances being more intense, yet milder to the patient, than in the larger ones.

In accordance with our favourable experience, we have recently treated with the cupping-glass diverse diseases ; it may be worth while to resume my old treatment of lupus with this appliance. I have repeatedly cured ulcerative lupus of the cheek with cupping-glasses. In 1897,[1] I had occasion to see two lupus cases which were treated by me in this manner, and one of which did not show a recurrence after three and a half years ; the other not after more than two years. The scars could scarcely be seen. In spite of this I declared in the first edition of this book that this treatment of lupus is without practical importance, as extensive lupus, attacking the nose and the mouth, cannot be treated in this manner, and because it would be better to excise lupus of the cheek, though accessible to treatment with the cupping-glass, and to suture the margins of the wound. I also believed that the method was excelled by Finsen's phototherapy. Perhaps improved technique of the suction apparatus will make it possible to treat the large lupus of the face in this manner.

With congestion hyperæmia by bandage I have seen no results, or only transitory improvement of ulcerative lupus of the extremities.

Jacoby[2] made the attempt to cure pulmonary tuberculosis by hyperæmia. He followed my idea which led me to the treatment of surgical tuberculosis, and in principle he worked with the same agents with which I treated tuberculosis in the beginning. He places the lung apices low, and treats the chest by a hot-water bath. Though I have

[1] Bier, "Heilwirkung der Hyperämie" (*Münch. Med. Wochenschrift*, 1897, No. 32).

[2] Jacoby, *Münch. Med. Wochenschrift*, 1897, Nos. 8 and 9 ; and Transactions of the Congress f. Int. Med.

repeatedly asserted that the active hyperæmia by heat is unfit for the treatment of tuberculosis, I do not wish to say that here the hot water could not influence favourably the disease. For, as I have already pointed out, hot water belongs to the agents that produce a less intense hyperæmia. To this must be added the fact that the deeply-situated tubercular foci, on account of the peculiar "inflammatory irritation," are capable of retarding a blood-current flowing fairly rapidly.

I stated earlier that I know a simpler mode of rendering the lungs hyperæmic for a definite period—viz., inhalation of rarefied air. This could be easily achieved by apparatus, but it no doubt would be simpler to compress the nostrils with the fingers, and to advise the patient to deeply inhale through the nose, and to exhale through the mouth, so that he becomes asphyxiated, but just to the point of tolerance.

This suggestion has been carried out in practice by Wassermann.[1] In a more perfect manner Kuhn[2] has accomplished hyperæmia of the lungs by a mask, designed by him, but based on the same principle. Link[3] endeavoured to obtain hyperæmia in one-sided tuberculosis of the apex of the lung by posture on the diseased side.

Recently Leo[4] has resumed my experiments made ten years ago to produce hyperæmia of the affected lungs with large suction apparatus. The objection that suction is here useless because the lungs have their own vascular system, independent of the external parts, I cannot accept, for in apical tuberculosis of the lung, as in the one under consideration, we find adhesions.

Whether all these experiments will produce something, and whether anything can be expected, I cannot judge. Experience must prove that.

[1] Wassermann, "Die Verwendung passiver Hyperämie d. Lunge b. Lungenschwindsucht" (*Zeitschr. f. Diät. u. Physik. Therapie*, vol. viii., No. 2).

[2] Kuhn, "Eine Lungensaugmaske z. Erzeugung v. Stauungshyperämie in d. Lungen" (*Deutsche Med. Wochenschrift*, 1906).

[3] Link, "Vorschlag z. Beh. einseitiger tub. Lungenaffektionen vermittels Lagerung d. Kranken" (*Zeitschr. f. Tub. u. Heilstättenwesen*, vol. iii., No. 6, 1902).

[4] Leo, "Über Hyperämiebehandl. d. Lungentuberkulose" (*Berliner Klin. Wochenschrift*, 1906, No. 27).

TREATMENT OF ACUTE INFLAMMATION AND ACUTE SUPPURATION OF THE EXTREMITIES WITH THE CONGESTION BANDAGE

I BEGAN to treat acute inflammation with congestion hyperæmia as far back as 1893. I started with gonorrhœic joints, and selected cases of recent acute osteomyelitis. I specially practised this treatment also in all possible cases of recent acute infection—*e.g.*, lymphangitis, freshly infected wounds, recent phlegmon of tendon sheaths—and in mild forms of relapsing acute osteomyelitis. Gradually I began to submit all forms of accessible suppuration, even the gravest, to hyperæmia treatment, as a matter of principle. This slow development and generalization of the procedure can be understood, when one considers what an enormous mass of prejudice I had to break through before making that step. For every surgeon, even if he were theoretically convinced that inflammation represents a useful process of defence, and therefore did not apply the entire apparatus of antiphlogosis, at least advised the elevation of acutely inflamed bodily parts accompanied by hyperæmia, in order to remove the harmful inflammatory congestion hyperæmia. Experience ostensibly had verified the correctness of this procedure.

TECHNIQUE OF HYPERÆMIA INDUCED BY A BANDAGE IN ACUTE INFLAMMATION AND SUPPURATION.

In acute infection and its sequelæ, congestion hyperæmia (otherwise than in tuberculosis) is usually maintained twenty to twenty-two hours daily. During the remaining two to four hours the limb is elevated in order to diminish the enormous œdema produced by the congestion bandage. Its entire removal cannot be accomplished in this short time. Joseph[1] has demonstrated that in spite of elevation the greatest part of the œdema remains. He proved that by direct measurements. After the intermission of two to four hours the bandage is reapplied in order to

[1] Joseph, "Einige Wirkungen des natürlichen Ödems und der künstlichen Ödemisierung" (*Münch. Med. Wochenschrift*, 1905, No. 40).

replace the removed œdema with a new one. This method is so applied by us rarely with less time, or with longer intermissions. It is but exceptionally that we fall below eight to ten hours daily, because experience has shown us that a shorter period does not suffice.[1]

Brief congestion hyperæmia is applied wherever the locality compels us to apply the constricting bandage or rubber tubing at one and the same place, as is, for instance, the case with the shoulder-joint. In such cases, if troublesome pressure phenomena make their appearance, the constrictor is not permitted to remain eight to ten hours at a time, but the application is interrupted by short intermissions, and the place showing traces of pressure is washed with alcohol.

But there are other cases in which the normal procedure of twenty to twenty-two hour congestion hyperæmia cannot be executed. One must necessarily know how to individualize with this method, just as with all others.

In acute inflammation, too, congestion hyperæmia demands careful technique, though not to the same extent as the long congestion hyperæmia previously practised by us in tuberculosis. Here, too, the procedure must not cause the patient any decided inconvenience. On the contrary, the bandage is to diminish the pain of the usually painful inflammation. Apart from the pain, the bandage must produce in really acute cases an increase of the inflammation, which I consider to be the natural healing process, its increase, and not diminution, being indicated. For this reason the phenomena of inflammation—redness, œdema, and swelling—become greatly increased during the application of the bandage, the lymphangitic strands become more intensely red, and occasionally the entire extremity becomes red up to the bandage. With progressing healing these phenomena, including the swelling, diminish even when the bandage is worn as before. This is a sign that the agent which produces the "inflammatory irritation" is overcome—that is, in

[1] Recently Frommer (*Wiener Klin. Wochenschrift*, 1906, No. 8) has recommended shorter periods of congestion hyperæmia, with which he has had good results. I also began with brief congestion hyperæmia in acute inflammation, but found it insufficient. I admit, however, that new experiments are here indicated, as it would mean a step forward if we could get results with brief periods of congestion hyperæmia.

other words, a sign of improvement or cure of the affection. If, on the other hand, the phenomena of inflammation increase for a prolonged time, or if they do not diminish, we have to deal with an abscess which must be opened.

If the disease improves under the treatment, the duration of congestion hyperæmia is gradually shortened until the bandage is finally worn from one to several hours daily. It should not be taken off too early, because we have often seen that the disease became aggravated, an experience which has been confirmed by others (Habs. Stich).

It is intended that congestion hyperæmia should cause improvement of nutrition; not disturb it. This can be seen from the fact that it has frequently prevented necrosis in cases in which such an outcome was the rule under antiphlogistic treatment. The procedure must therefore hinder the venous return flow, but not the arterial influx. In acute inflammation the extremity must not show increased lividity; it must remain warm, and pulsation must always be plainly felt.

In this respect I would compare the blood-stream with a pond traversing a meadow, and furnishing irrigation ditches for the meadow. If the farmer place a weir in the pond below the meadow at first the outflow of water ceases, and the meadow is flooded. After this has occurred as much water as before flows to and off, but the meadow remains flooded. The weir which we apply in acute inflammation in the outflowing part of the stream is the congestion bandage. Inflow and outflow remain alike, or approximately so; nevertheless, we flood the tissues with blood or its components, as the case may be.

Occasionally blisters appear at the inflamed parts subjected to congestion hyperæmia. The bandage has usually been applied too firmly in such cases, or there is an abscess which has to be incised.

I have never hesitated to apply the congestion bandage over lymphangitic strands; as a rule, the lymphangitis and lymphadenitis improve also centrally from the bandage, because the latter favourably influences the primary trouble, and hinders the reabsorption of the bacteria and their toxins.

The bandage, if possible, is not to be applied too close to

the inflammatory focus ; it is, for example, a mistake to apply it to the root of the fingers in inflammation of the fingers ; it is best applied at the forearm or, better still, upper arm. Furthermore, in all acute grave cases rest in bed is essential.

The part of the extremity peripheral from the inflammatory focus is not bandaged. The entire procedure, therefore, consists of the simple application of the bandage.

The bandage, after having been applied ten to eleven hours, is reapplied to a different place to prevent pressure. If it is applied lower, it must often be constricted tighter after a while, because it becomes loose after the removal of the œdema. If the skin is tender, the bandage is lined with a few turns of flannel ; otherwise blisters occasionally develop at the margin. In such cases we have made good use of Henle's tubing, described before, which can be inflated with air, and is milder in action than the bandage.

It is important in acute suppuration to loosely apply all dressings during congestion hyperæmia, for the least pressure of the dressing suffices to prevent the appearance of hyperæmia and swelling at the place of infection. For extremities we make use, for the fastening of the dressings, of loosely applied towels, which can be pinned together. They are more practical than bandages, permit the most pronounced swelling, and can be applied and removed without pain.

Soon after the application of the bandage one should repeatedly investigate whether it is applied too firmly or too loosely, and whether the right degree of congestion hyperæmia has been obtained. After a few days the patients themselves state whether the bandage is correctly adjusted. It is the weak point of the procedure that the congestion hyperæmia must be graded with the greatest care. Applied too feebly it does no good ; applied too firmly it does harm. For this reason it must be watched with great exactness. The closest attention is required during the first few days. For I am convinced that the possible induction of inflammation and suppuration is decided in the first few days. As proof for this I quote the following case :

16. A boy, eight years old, was suddenly taken ill on February 23, 1904, with a violent inflammation in the region of the right shoulder-joint. He was admitted March 1. The entire right arm was œdematous, especially

the region of the shoulder-joint. The joint was stiff. All attempts at motions were very painful, and were participated by the shoulder-blade. Fluctuation could be felt on the anterior side of the joint and the highest part of the upper arm. An incision 2 centimetres long was made in that part; 30 to 40 c.c. of pus were evacuated. In the cavity rough bone presented itself, denuded of periosteum at its front and inner side. The shoulder-joint was open, and on motion much pus was evacuated. On rubbing from below towards the wound, about 20 c.c. were squeezed out. Irrigation with saline solution was practised as much as possible, and the small wound closed with silver wire suture. A constrictor was applied above the shoulder-joint. It was worn ten hours daily. The congestion hyperæmia had to be discontinued after three days, because the constrictor had produced in the axilla extensive excoriation of the skin. But on the whole the hyperæmia, which appeared in the most intense form, had changed the entire aspect of the disease, in spite of the short application and in spite of the closure by suture of the large abscess cavity. The fever had disappeared, and remained away thirty-six hours after institution of the procedure (see Chart I.), and the pain which had previously existed diminished. For external reasons, the boy had to be discharged before the excoriation of the skin had healed. In the place of the incision wound a sinus appeared, and two others had broken through the axilla; all three yielded pus sparingly.

Chart I.

The boy was readmitted July 18, because the sinuses still existed, and the excoriation showed no inclination to heal. Under anæsthesia the sinuses were opened. They led to the bone, which was covered by periosteum, nowhere showing necrosis. The excoriation did not heal, perhaps because passive motions had been made with the joint, which threatened to become stiff. For this reason the excoriated ulcer was excised November 23, and the wound margins united by suture. The wound healed by first intention.

The bone has healed without necrosis; the joint is completely mobile.

Though on account of excoriation the congestion hyperæmia could be applied but three days, it produced a complete cure without bone necrosis, and without ankylosis, because during the short time of its application it had caused an enormous inflammatory swelling and redness.

In the application of congestion hyperæmia I have again and again experienced that the results change when a new assistant, or even a new nurse, enters the service. For this reason only reliable people should be selected for so delicate a method. I advise those physicians who are not yet familiar with the method to restrict themselves in the beginning to those cases with a better prognosis—viz., (1) very recent acute inflammation of all kinds; (2) subacute and mild inflammatory affections, even if they have

existed for some time; (3) suppurating joints due to gonorrhœa, pyæmia—after which they may undertake the treatment of the therapeutically more difficult cases of progressed phlegmons of the tendon sheaths and osteomyelitis. If one without sufficient technical knowledge attempt these difficult cases, from the very beginning poor results and exacerbations can scarcely be avoided, which are usually ascribed to the method, though in reality due to personal lack of knowledge. The uninitiated should, especially, not treat by this means long-standing suppuration endangering life, until he has convinced himself of the correctness and sound logic of the principle. For I know with what antagonism and prejudice surgeons take up congestion hyperæmia, and I fear there will be an inclination to attribute harmful results, which may have lain in the nature of the thing, to the method. For there always will be grave cases of acute infection, leading to amputation and death, in spite of congestion hyperæmia. It is not fair to demand of a remedy that it heal all; there is no such panacea, and there will never be one.

For this reason I emphasized in my earlier publications on this subject that this method, until a wide experience shall have been collected, is unsuitable for the use of the general practitioner, but should first be tested by colleagues who have at their disposal a hospital.

Meanwhile I have received from general practitioners such enthusiastic written and oral communications about their brilliant successes in phlegmon of the tendon sheaths and suppurative joints that I no longer make this demand, but would advise that physicians familiar with surgery should practise this method, but even then only when they can keep an eye on the patient for some time.

Like Danielsen and Jerusalem, we, too, have had good results with ambulatory treatment, which certainly must be executed with great care. Serious cases are always admitted by us to the hospital.

In acute inflammation and suppuration we have a good test of the correctness of this method in the relief of pain, which appears pretty regularly and usually very rapidly. This is most striking in acute suppurating joints and phlegmon of tendon sheaths. Whoever holds to antiphlogistic views, and

has not made himself familiar with the logic of our method, may become alarmed on seeing the intensely swollen, fiery red, congested extremity. The patient, however, as a rule is satisfied with the remedy, because it removes pain. Usually the patients state that the pain returns, though in a less degree, during the short interruption when the bandage is removed.

By this it is not meant to affirm that there are no cases which do not at once show this diminution of pain; on the contrary, some show an increase. This is met with in diverse diseases, especially in gonorrhœic inflammation of joints. I will explain how to meet this when I come to discuss this affection. Arnsperger's[1] advice to abandon congestion hyperæmia as useless, if it has not relieved or removed the pain after two hours, is erroneous. If we had followed this principle we should have missed many a good success. This is the advice I have earlier given for the treatment of gonorrhœic joints, but which I have abandoned as false. In acutely inflamed joints and in phlegmon of tendon sheaths, movements are undertaken as soon as the disappearance of pain permits, in order to produce good function of the affected extremities. I will discuss this in detail when dealing with the diseases concerned. Our surgical measures take this point too little into consideration. The care for the preservation of limb and life stood in the foreground.

I do not wish to close this chapter on the technique of congestion hyperæmia in acute inflammation without again pointing out that it is entirely different from that used in tuberculosis, viz.:

In tuberculosis congestion hyperæmia is to be applied for a short period, and no œdema must develop. In acute inflammation it is the reverse. Here we desire the strongest possible fiery œdema. But one must not forget to elevate the extremity during the intermissions, so that part of the œdema can be removed. For we desire a change of the œdema; we want a fresh œdema to take the place of the old one. We do not succeed in entirely causing its disappearance, but this is not necessary. If the disease drags along from having been compelled to maintain prolonged congestion hyperæmia in the manner described (a rare case),

[1] Arnsperger, "Erfahrungen mit Bier'scher Stauung bei akuten Eiterungen" (*Münch. Med. Wochenschrift*, 1905, p 2540)

care must be taken to entirely remove the swelling of the extremities by elevation for from one-half to a whole day now and then, and only afterwards continue the congestion hyperæmia.

Œdema occurs in a more limited degree when larger wounds are present. In such cases it flows externally. These conditions are specially met with when we practise prophylactic congestion hyperæmia for wounds suspected of infection, which we will describe later on. In such cases the rubber bandage can be worn without interruption several days. This, however, is only permitted when the patient feels comfortable with it.[1]

Suppression of Incipient Suppuration by Congestion Hyperæmia.

In some of my earlier contributions, as well as in the clinical histories quoted below, cases of suppression of incipient suppuration will be found due to congestion hyperæmia. As examples I also quote five cases of recent pyæmic

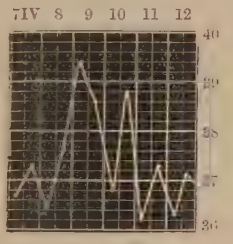

Chart II.

metastasis, which I saw developed during my observation. I remark that, unless otherwise mentioned, all statements about temperature mean that it is taken in the axilla.

17. I resected, February 4, 1904, an almost inoperable carcinoma of the rectum from a woman aged sixty. The wound suppurated profusely for a long while. April 3 a pyæmic metastasis appeared at the left wrist, with chills and a rise of temperature up to 39·4° C. The joint was very red, swollen, and extremely sensitive. Congestion hyperæmia was applied at once, and maintained twenty hours. The painfulness disappeared rapidly, and the disease left no trace by April 11. Temperature sank to normal, and the congestion hyperæmia was discontinued. The temperature curve is depicted in Chart II.

[1] The treatment of acute suppuration with congestion hyperæmia described by me in *Münch. Med. Wochenschrift*, 1905, Nos. 5, 6, and 7.

18. A woman, forty-two years old, entered the clinic June 30, 1903, with an intense phlegmon of the left hand and forearm. The arm had to be amputated July 3, because the general condition was seriously involved, suppuration having progressed in spite of extensive incisions, and septic diarrhœa and a pyæmic metastasis in the phalango-metacarpal joint of the right thumb, with intense phenomena of inflammation, having made their appearance. For the last named congestion hyperæmia was instituted immediately. July 7 the metastasis had completely disappeared after six days' application of the remedy. The high temperature and its decrease, of course, were due in the first place to the intense phlegmon of the left arm and its amputation, so that it cannot be utilized for our purposes.

19. A tanner, twenty-four years old, was admitted December 19, 1904, with a deep abscess of the hip-joint, with high temperature, and in a miserable condition. The following morning he complained of pain in the left elbow-joint, which appeared suddenly, and which increased during the day. At the same time the temperature increased still more. In the afternoon the joint became somewhat swollen, and was flexed at a right angle. The least attempt to change the position of the arm produced violent pain. At 7 p.m. congestion hyperæmia was instituted. This was followed by a decided swelling of the entire joint, as observed only in acute inflammatory diseases. The next morning, after an application of the bandage for thirteen hours, the affection of the elbow-joint was practically removed. The patient made active motions in approximately normal limitations without sensitiveness; extreme passive extension and flexion produced slight pain. Congestion hyperæmia was continued until December 23. The abscess of the hip was incised December 21 under ether. About ¾ litre of blood-coloured pus was evacuated. Finally a thrombus as long as a finger, and divided like a fork, which had become soft and partially purulent, was evacuated, accompanied by a profuse venous hæmorrhage, which was arrested by tamponade.

The course of the fever is without interest for our purposes, because it was principally influenced by the grave primary disease.

20. A baker, thirty-five years old, appeared at the surgical clinic May 5, 1904, with pronounced suppuration of all accessory cavities of the nose, for which he had been unsuccessfully operated thirty-eight times. May 14 he was operated anew after Killian's method. The operation was followed by profuse suppuration, and the patient had considerable fever. In the night of May 23-24 a pyæmic metastasis in the left elbow-joint suddenly made its appearance, the patient complaining of intense pain. The temperature, which had fluctuated in the preceding days between 38·6° and 38·9°, rose to 39·5°. The metastasis retrogressed completely after application of congestion hyperæmia for nine days. Here, too, the course of the temperature cannot be utilized for our purposes, because it had also been influenced by the primary suppuration.

In these four cases of painful pyæmic metastasis of the joints, the immediate diminution of the pain and the rapid suppression of all other phenomena of inflammation, after a brief intense increase, produced by the congestion hyperæmia, was very striking. All four joints have healed so completely that even the most careful examiner could not demonstrate even a trace of the past disease. The longest period required to re-establish complete function without any restriction whatever was (in Case 20) nine days.

We were not quite as fortunate in the following case. We could not suppress the suppuration. Nevertheless, the course of the disease was strikingly short and favourable.

21. A sixteen-year-old boy was shot through the abdomen August 1, 1904, necessitating laparotomy and suture of the intestine. A fæcal fistula developed, followed by a grave infection. August 5 the boy suffered from an intense inflammation of the left, and the following day also of the right, parotid gland, with high temperature, great swelling, and pain. Chills came on repeatedly. Commencing August 6, a congestion bandage applied to the neck was worn through the day and removed for the night. August 8 an abscess broke through the external auditory canal on both sides. In front of both ears, in addition, an abscess of the parotis made its appearance. August 17 the right one opened spontaneously; the left one, which was on the point of doing so, was emptied by a small incision. Both healed in the next fourteen days without leaving any trace. The disease left no disfigurement whatever. The small scar can be found with difficulty at the place where the small incision was made. A similar case was observed by me recently.

The suppression of such incipient acute inflammatory foci of infection will always remain the most fruitful field for congestion hyperæmia. It is, as numerous cases during an experience of more than eleven years have taught me, for such cases a really wonderful remedy.

The earlier congestion hyperæmia is instituted in acute inflammatory affections, the better the results. Alas! the cases come too late for treatment, at a time when the bacterial toxins have produced necrosis, which naturally cannot be removed. I believe the congestion hyperæmia would have good results in military hospitals, because soldiers are compelled to report themselves immediately they become ill. I am indebted for a great many of the recent cases which I have treated to the appreciative co-operation of the senior military staff-surgeons Gerdeck and Oertel in Bonn.

Congestion hyperæmia has proved itself of great value to us in a striking manner in operative wounds, made by us, which for some reason or other had become infected. In numerous cases the method has been applied with such success that I believe I am able to assert that we have made a decided progress in the certainty of our results, with which no other method can compare. Here are a few examples:

22. Labourer, nineteen years old, while chopping wood November 16, 1905, injured the back of his left hand with an axe. He was admitted to the surgical clinic the same day.

On the left dorsum of the hand was a diagonal wound, beginning at the metacarpo-phalangeal joint of the small finger, and terminating at the epiphysis of the radius. All extensor tendons were cut through, all carpal joints opened, and the bones in the course of the wound injured.

The tendons were sutured with catgut, the cutaneous wound with silk.

November 20 the dressings had to be changed on account of high temperature (up to 39·2° in the axilla) and violent pain. The dorsum mani was intensely red and swollen, pus exuding between the sutures on pressure. A suture was removed, and the pus squeezed out as much as possible. This was followed by congestion hyperæmia applied for twenty hours daily, which produced an enormous swelling. The dressing was changed daily and the pus evacuated. The pain disappeared, and the temperature fell rapidly to normal. The wound, except at the small space where the suture was removed, healed by first intention. The tendons uni ed. The patient was discharged January 24, 1906, with normally movable fingers.

23. June 26, 1905, labourer, twenty-six years old, transverse fracture of the patella, which I united by placing a thick silver wire around the fragments. I also sutured the torn fibrous extensor ligaments with catgut. The skin was united with close silk sutures.

In the night of the 28th-29th the patient was attacked by delirium tremens, jumped from the bed, tore open the dressing, and partially also the skin wound. The Röntgen picture showed that the silver wire was torn, and that the fragments of the patella had again separated. For this reason patellar suture was again applied July 3 in the same manner as before. The knee-joint suppurated with considerable fever and great malaise. A few cutaneous sutures were removed, but the knee-joint was not opened. The suppurating joint was treated with congestion hyperæmia from July 4 to 21. The temperature soon sank, and the suppuration in the joint ceased.

The fragments of the patella united well, and the patient was discharged October 14, after prolonged orthopædic treatment.

The condition of the injured man on March 5, 1906, was as follows: The fractured pieces of the patella have firmly united. The joint can be moved actively in moderate limitation, passively in the suction apparatus up to more than half a right angle. Further treatment will presumably produce a still greater mobility of the joint.

The following case may be published with this series:

24. A messenger, forty-eight years old, sustained, January 9, 1906, a transverse fracture of the patella by falling on the knee. He was admitted to the surgical clinic January 11. As the fractured ends were not widely separated, and as the fibrous extensor ligaments were preserved, no treatment by suture or dressing was needed. To remove the effusion of blood the joint was placed in the hot-air box for one hour daily, and moved actively and passively from the very beginning. January 17 the affected knee became severely inflamed. The temperature rose gradually. Aspiration with a hypodermic syringe brought out pus, which contained staphylococci in a pure culture. Congestion hyperæmia was instituted. The affection improved rapidly. The temperature was normal from the 29th. The joint was aspirated on the 28th, but only blood-coloured serum was evacuated, which proved sterile. During the treatment careful passive movements were undertaken.

February 8 the knee had no more swelling, and active and passive movements were possible to the greatest extent. The congestion hyperæmia was discontinued, and in its place hot-air treatment applied for one hour daily. The patient was discharged March 1 with a normal joint.

In the after-treatment of infected wounds, the cupping-glass, too, plays an important rôle. Not infrequently laparotomies, which cannot be executed aseptically, and even radical operations for hernia, are followed by mild small infections, leading to the formation of sinuses. If these are treated according to the rules, which will be given in a subsequent chapter, on the application of the cupping-glass, the sinus closes rapidly, occasionally even after one treatment. If silk sutures have been employed, the cupping-glass sucks them out, or they heal in spite of the suppuration. In the same manner infected wounds of the trunk can be successfully treated with the cupping-glass.

These observations of ours have also been confirmed by others.

Change of Hot Abscesses into Cold Ones.

In rare cases the congestion hyperæmia changes hot abscesses into cold ones, as is shown by the following examples :

25. A boy, seven years old, entered the surgical clinic July 28, 1904, with a violent and very painful acute inflammation of the right leg. The main swelling and redness occupied the outer side, covering it in its entirety. In the middle there was plain fluctuation. Aspiration showed thick pus, containing staphylococci. This abscess was purposely left alone, the treatment being limited to the institution of congestion hyperæmia. The abscess became a cold one as early as July 30. All phenomena of inflammation had disappeared ; the previously increased temperature sank to normal. The abscess still remained to the former extent, and had considerably thinned the skin. August 5 the abscess broke through, and discharged a thorn 1 centimetre long. The pus was squeezed out through the small perforation without incising the skin any further. August 9 everything had healed, and the patient was discharged.

I have not at my disposal an example of the "cooling" of a streptococcus abscess by congestion hyperæmia of recent date. I must therefore make use of one from the year 1901, which I have already described in detail elsewhere :[1]

26. A butcher, eighteen years, was admitted March 14, 1901, to the clinic at Greifswald with an unusually intense inflammation in the region of the right knee-joint. The diseased extremity was so intensely swollen that its circumference was 5 centimetres larger than that of the healthy one. In addition there was an intense lymphangitis of the thigh. Temperature was raised, the general condition greatly disturbed. The patient had delirium during the first night, jumped from the bed, and had to be watched. Congestion hyperæmia was instituted the next morning. The

[1] Transactions of the Nineteenth Congress f. Int. Medicine, 1901, p. 219.

general phenomena, the sensation of illness, and fever, rapidly disappeared under it, as did the phenomena of inflammation, so that the congestion bandage could be removed as early as March 18. After the disappearance of the swelling, an abscess without any phenomena of inflammation was found below the knee-joint, which on incision yielded chocolate-coloured pus. A culture of streptococci was obtained from the latter.

Disappearance of Abscesses by Congestion Hyperæmia.

27. Boy, twelve years, admitted July 23, 1904. An intense inflammation like a carbuncle was found at the occiput and back of neck. The skin above both occipital bones to the middle of the back of the neck showed hard infiltration; the vicinity was œdematous and sensitive to pressure. In the middle of the hard swelling there was a soft place of the size of a walnut. Aspiration yielded thick pus containing staphylococci. The head became very stiff, and was kept in a drooping position. Temperature of the body was scarcely elevated (37·9° C. in the axilla).

A congestion bandage was applied around the neck, and worn throughout the day. As early as July 26 the head was freely movable.

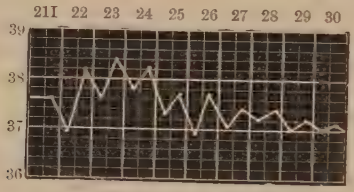

Chart III.

and the affected place without pain. The hot inflammation had become absolutely cold. Aspiration practised on July 28 gave clear serum. With continued treatment everything pathological, including the abscess, completely disappeared by August 2, when the patient was discharged.

28. A day-labourer, twenty-nine years, suddenly took ill eight days before admission with chills and severe pain at the inner side of the right leg.

He was admitted January 22, 1904, with a very painful and intense inflammation of the right (lower) leg, the upper two-thirds of which were intensely red and œdematous. The main redness and swelling were over the inner surface of the shin-bone, which was sensitive to pressure. The bone felt thickened, but the Röntgen picture showed nothing abnormal. Fluctuation could not be demonstrated. Congestion hyperæmia was applied twenty-two hours daily. Fever, swelling, and pain, diminished in a few days, with the exception of the mentioned place at the shin-bone. Here fluctuation plainly developed, which reached its maximum January 28. I intended to permit the abscess, which evidently was there, and which already had caused thinning of the skin and become cold by the congestion hyperæmia, to break through spontaneously; but it retrogressed under continued application of congestion hyperæmia, and disappeared completely after a few days. The patient was discharged cured February 15. The only abnormal thing left was a slight thickening of the upper end of the tibia. The course of the temperature is shown in Chart III.

Other cases of disappearance of hot abscesses will be described in the course of this work. I could quote many more incipient phlegmons and panares where, according to all our experience, pus should have been present, which, however, retrogressed by congestion hyperæmia. I cannot produce the strict proof that pronounced suppuration had been present.

We therefore obtain by the application of congestion hyperæmia in suppuration of the extremities similar conditions to those with which we have become familiar in other organs. We know that a large number of appendiceal abscesses after an originally hot course become cold, and disappear without aid. Something similar is observed in many cases of osteomyelitis. It is noteworthy that these abscesses, like those removed by congestion hyperæmia, change into more or less clear serum.

Peritoneum and bone marrow have the natural property of suppressing infection by an extremely intense "inflammatory reaction," and of reabsorbing pus. This property we can artificially give to other bodily parts which, unaided, cannot, as a rule, accomplish this.

Though it is an established fact that occasionally ready formed abscesses can be caused to disappear by congestion hyperæmia without intervention by incision, this is not the rule by any means, and should not be. For even division of the abscess is nothing else but the imitation and improvement of the natural healing process. Suppuration generally has as its object the removal from the body of something foreign and obnoxious. On the whole, the hot abscess fulfils its mission with careless energy. It breaks through to the outside, often through the most tortuous channels, and recognizes no obstacles. But we know that this process takes place frequently with great destruction of tissue, and with great tortures and damage to the patient. But what Nature achieves in a long time, in roundabout and false ways, with considerable danger and pain for the patient, the humane incision accomplishes without danger in the shortest time, and in the least injurious way, by dividing the hindering tissues.

We know, besides, especially from our experience with appendicitis, that for the prognosis it is better to direct a

hot abscess outward than to leave it to resorption and encapsulation.

Apart from this, some of our observations also show that the omission of prompt evacuation of pus means damage to the patient.

I desire not to be misunderstood. *Our procedure, occasionally of not incising obvious abscesses when the symptoms of the disease permitted it, had merely served to indicate a matter of principle.* It was to demonstrate the enormous effect of induced hyperæmia. I advise everyone else in such cases *to incise.*

But we require with this remedy smaller and less mutilating incisions. On the other hand, the abscesses should be carefully and thoroughly incised when grave circulatory disturbances are present. In phlegmon of tendon sheaths I prefer several smaller incisions to prevent too much exposure of the tendon and its slipping from the groove. It may be practical to make lateral incisions in the suppurating tendon sheath, as has already been recommended by several surgeons.

It is essential to always examine whether the congestion hyperæmia produces new abscesses, and to incise them as soon as they are recognized. They are to be suspected when fever and phenomena of inflammation persist.

The question of incision of abscesses has, in itself, nothing to do with congestion hyperæmia. Whoever believes it necessary to incise freely may do so, and yet apply in addition congestion hyperæmia. I have, however, attempted to limit myself to small incisions, which mutilate less and heal with less scar formation. As a general rule this attempt has been successful.

My reserve in operating developed from my antipathy, which grew from year to year, for the ugly, frequently even extreme and mutilating, operations which we are compelled to undertake in grave phlegmonous diseases. I hope to have contributed considerably to their restriction, and to be able to restrict them still further in the future.

Behaviour of Acute Suppuration under Congestion Hyperæmia.

Congestion hyperæmia affects variably open suppuration, so that a universal rule cannot be laid down. Occasionally suppurating wounds dry rapidly. As a rule, however, congestion hyperæmia increases the suppuration. It leads either to large quantities of serous or to thick creamy pus. But even the latter soon gives place to an extraordinarily profuse serous or slight bloody-serous excretion, which saturates in a little while even thick absorbent dressings.

In five cases we noticed that the pus began to stink under the influence of congestion hyperæmia, and occasionally to throw out gas bubbles. This was so uniform in all cases that it could not be a mere accident. They all were grave infections, which, however, did not become worse by this transformation of the pus. I observed these cases in the beginning of my experiments ; I have not seen them since.

The termination of suppuration usually occurs rapidly under congestion hyperæmia. It leads to rapid expulsion of necrotic tissue, and, what is more important, it preserves the life of limbs, to whose death we had become accustomed as something unavoidable and self-evident with the usual treatment. The remedy, furthermore, localizes suppuration to a great extent, and thereby saves the patient large, injuring, and mutilating incisions, and re-establishes the function of the diseased bodily parts to a degree we have heretofore considered impossible.

Surgical Treatment of Acute Suppuration under Congestion Hyperæmia.

Abscesses are opened with not too large incisions under local anæsthesia wherever it is possible to do so thoroughly and painlessly ; as a rule, the chloride of ethyl spray suffices. I make use of general anæsthesia, especially the excellent Sudeck's ether plan (a method of quickly producing transient unconsciousness by the inhalation of a rather large quantity of ether—Translator), or spinal anæsthesia in really grave suppuration, as in acute osteomyelitis, and such conditions

in which the function of the bodily part is endangered, as in phlegmon of the tendon sheaths. For in these cases local anæsthesia does not permit of working carefully and painlessly. Congestion hyperæmia is again applied two to three hours after incision, when hæmorrhage has completely stopped.

I emphasize again the point that in spite of the above-quoted observations it is undoubtedly necessary to incise all abscesses. It is not easy always for the untrained to find them. The intense œdema masks them. For this reason the change of dressings is best made after elevation during the intermission, and examination is to be undertaken when the œdema has diminished. Furthermore, abscesses not infrequently become cold and painless under congestion hyperæmia. This again makes recognition more difficult. For this reason a suspected place should always be incised by a stab under chloride of ethyl spray. If an abscess is not found no harm has been done.

To permit *an abscess to become large* under congestion hyperæmia is a serious error. Large abscesses should always be recognized.

The abscesses are only exceptionally drained and never tamponed. In surgery much misuse is made with tamponade. It is not at all surprising that a tendon dies when it has been enveloped with a wick-like foreign body which sucks up all its nutritive juices, and that the same fate befalls a bone when thus dried artificially.

This should be taken to heart also in regard to many other wounds. For example, I do not now tamponade the suture line after resection of the rectum, but bring it into position with the surrounding wound surfaces. I have better results in the healing of the stumps.

The wound produced by the incision is therefore simply covered with an aseptic absorbent dressing, which must be large, when a profuse serous excretion takes place.

The wounds are dressed daily, and the pus is irrigated with physiological saline solution or sterile water. If small incisions have been made, such as we prefer in phlegmon of the tendon sheaths, the pus must be removed by careful squeezing and massage.

Change of dressings should be undertaken with sterile gloves if possible.

If, in spite of diminished duration of treatment, the patient has been free from fever for a few days, the after-treatment should consist of hot-air baths, even if suppuration is still profuse. The hot air is at first applied for ten to twenty minutes, which is rapidly prolonged to half to one hour, if it be tolerated. Hot air is very suitable for the sequelæ of acute infection; it hastens demarcation, stimulates the formation of granulation, and removes the congestion œdema and stiffening. It is therefore best suited as after-treatment of osteomyelitis and phlegmon of tendon sheaths.[1]

Influence of Congestion Hyperæmia on Rise of Temperature.

I have seen a whole series of grave acute infections in which the previously increased temperature sank considerably immediately after the institution of congestion hyperæmia. Occasionally the temperature sank to normal, and remained so. We make no mistake in assuming that the remedy in these cases has immediately suppressed and removed the cause of the disease. For contemporaneously with the change of temperature the other phenomena (pain, inflammation, sensation of illness) also disappear, to return no more. I quote in proof of this kind of influence on the temperature a case of osteomyelitis, which from the very beginning ran a mild course, did not open, and which was cured rapidly and permanently by congestion hyperæmia:

29. A boy, fifteen years old, suddenly became ill five weeks previous to admission, while at work, with severe pains in the shoulder. At first he was able to continue his work, but had to give it up very soon.

He was admitted November 9, 1904. The entire left upper arm was swollen. The upper half of the bone felt thickened; the skin over it was red. Pressure marks from the finger did not disappear. The main œdema occupied the inner side, somewhat above the elbow-joint. The shoulder-joint was swollen and completely stiffened. Attempts at movement and pressure on the sulcus intertubercularis gave pain. Congestion hyperæmia of the shoulder was applied six hours daily, and the shoulder, whose painfulness rapidly diminished under this remedy, was moved actively and

[1] A distinct difference is to be made between acute infection and its sequelæ. It is a bad misuse to name, for instance, necrosis and its suppuration, produced by an acute osteomyelitis, "chronic osteomyelitis," as repeatedly happens. With the same right we could designate the ruins of a house destroyed by fire a "glowing fire."

passively. After three days the swelling had diminished and the shoulder-joint became mobile.

December 3 the swelling of the arm had gone down, and the shoulder-joint was actively and passively movable in normal limitations. Congestion hyperæmia was discontinued. The boy was discharged completely cured December 7.

The effect of the remedy on the bodily temperature can be plainly seen from Chart IV.

In other cases congestion hyperæmia influences the temperature in an entirely different manner.

While in the cases described above the institution of congestion hyperæmia immediately and permanently removes the entire disease, and with it also the increased temperature, we occasionally see that the temperature sinks only while the bandage is applied, and rises as soon as it is taken off. As an example for this I show the temperature chart of the

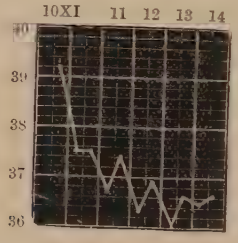

Chart IV.

eighteen-year-old butcher whose case was previously described as No. 26. In this case I applied congestion hyperæmia by the hour with interruptions. The period during which it was maintained is indicated in Chart V. by a dotted line. It can be plainly seen that the temperature, especially when the disease was at its height, sinks when the bandage is applied, and rises when taken off. This is all the more noteworthy, for the time of the sinking of the temperature falls during the period of the normally daily increase.

The explanation of this phenomenon is not difficult. As was explained in the General Part, the congestion hyperæmia and the œdema developing later diminish the reabsorption of the bacterial toxins. The following experience confirms this view: We have repeatedly observed that during elevation of the extremities, which had become œdematous and acutely inflamed after congestion hyperæmia, the patients looked ill

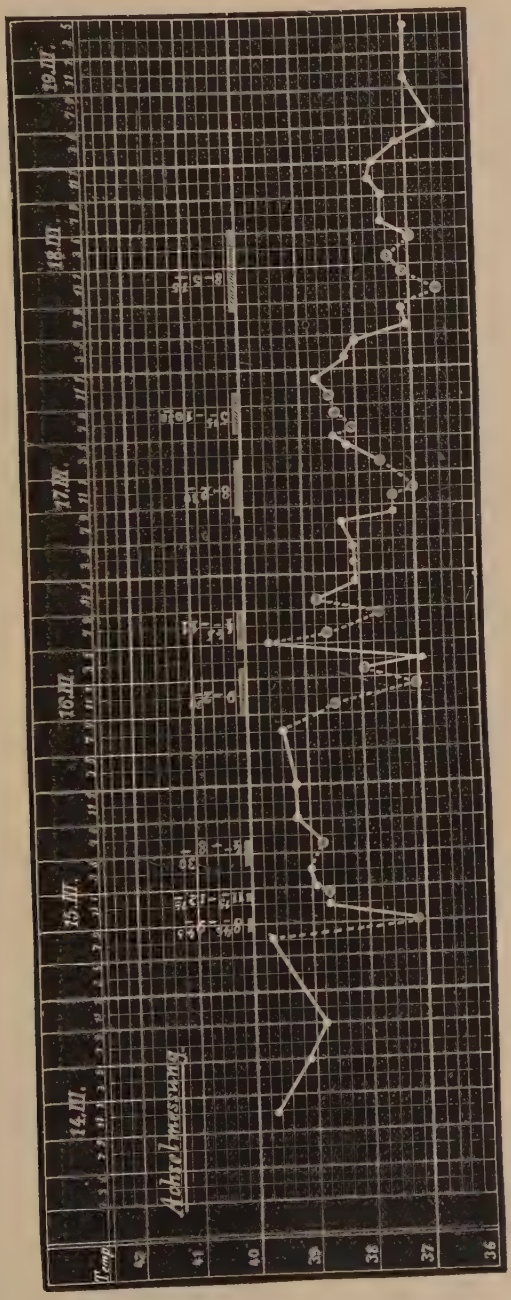
Temp.
42
41
40
39
38
37
36
Axillar-Messung
14.III.
15.III.
16.III.
17.III.
18.III.
19.III.

Chart V.

and feverish, and felt worse than when the congestion bandage was applied. With the disappearance of the œdema the quantities of bacterial poisons stored in it naturally entered the circulation.

The two described forms of influence of congestion hyperæmia on the temperature cannot always be demonstrated, and not as a rule in so marked a manner as in the two reported cases. Very often we observe that the remedy has no influence whatever on the temperature. Positive conclusions for the course of the disease cannot be drawn, as is shown in the following case :

30. A girl, seven years old, became ill about four weeks previous to admission, with pain and swelling in the right thigh.

Admitted June 18, 1904. The right thigh was much swollen ; fluctuation could be demonstrated on the outer and inner side. A large abscess cavity was opened at the outer side by an incision 6 centimetres long. The inferior side of the diaphysis of the femur was denuded of periosteum in its under two-thirds. The pus contained staphylococci. Congestion hyperæmia was instituted. Profuse suppuration appeared. As this had insufficient drainage, a counter-opening was made at the inner side. Suppuration gradually decreased. August 20 the wounds have closed by scar, and the disease is cured without necrosis. The patient was discharged September 5. The right femur was thickened, the function of the leg normal.

The case took a strikingly favourable course, although it came for treatment late after the beginning of the attack ; and though we had to deal with extensive disease of the bone and denudation of periosteum, healing took place without necrosis and disturbance of function.

The congestion hyperæmia which accomplished this had no influence in the first few weeks on the temperature characteristic of osteomyelitis.

Prolonged fever *per se* is therefore no reason for abandoning congestion hyperæmia. This holds good especially for osteomyelitis. It is presupposed that the general condition is undisturbed, the appetite preserved, and that there are no essential pains.

Treatment of Acutely and Subacutely Inflamed Joints with the Congestion Bandage.

Among the acutely inflamed joints for which treatment with congestion hyperæmia is applicable, I mention in the first place the arthritis of gonorrhœics. I have treated with

this remedy various forms of this inflammation, and have seen the best results in such cases, for which heretofore we lacked a remedy, and which are so grave that they lead to ankylosis, or at least to the severest stiffness, and which Koenig named "phlegmonous." As is known, apart from the joint proper, also the structures near it, especially the tendons, are involved. These cases are characterized by intense pain.

I know of no other remedy which has as prompt an effect in any disease as the hot congestion hyperæmia, which can be very easily produced in such cases. An hour after the application of the remedy the pain is greatly diminished, and in cases in which the least touch, especially an attempt to move the stiff fingers, is accompanied by maddening pain, any movement being simply an impossibility, to the greatest surprise of the patients, careful passive movements can be undertaken, and, what is more important still, without any injury to the patient. The patient soon learns the advantage and agreeableness of the remedy, and asks for the congestion bandage when it is removed for some time. It has proved itself the best hypnotic when worn during the night, and has given longed-for rest to sufferers who have been unable to obtain any sleep in spite of powerful narcotics.

31. A man, twenty years old, contracted gonorrhœa three months prior to admission. Five weeks ago he suddenly became ill during the night, with violent pains in the right wrist-joint, which robbed him of his sleep. A physician pronounced it a case of acute articular rheumatism, wrapped the joint in cotton, applied the ice-bag, and finally iodine, until the skin became inflamed and cracked. When all this proved useless, the extremity was bandaged to a splint, which the patient has worn for the last four weeks. All this without any result.

The patient was admitted July 9, 1902. The region of the right wrist was very much swollen. The circumference of the wrists was, on the right one $25\frac{1}{2}$ centimetres, and on the left one $18\frac{3}{4}$ centimetres. The back of the hand was œdematous, which œdema could be followed up to the region of the elbow-joint. The palm was swollen. Redness of the skin was absent. The fingers were fixed in extension, the hand in pronation. The region of the wrist and of the extensor tendons was extremely sensitive to touch; the least attempt to move the wrist or the fingers caused the patient to cry out aloud. He is said to have slept for the last weeks not at all through the day, and very little during the night, because the pain in the wrist, in spite of its being fixed to a splint, was unbearable. He was in a poor general state. The joint between carpal and metacarpal bones was extremely sensitive to touch. The Röntgen picture shows each metacarpal bone surrounded by a broad bright margin. It looks as if each of them was surrounded by a layer of cotton, and therein placed alongside each other. The upper ends of the second to fifth metacarpal

bones show the most decided changes. Their articular ends are attacked by caries, and show periosteal granulations; but neither they nor the bones of the fingers show the atrophic changes usually accompanying inflammation of the joints. The soft parts of the arm are atrophic, while those of the forearm cannot be made out on account of the œdema. The patient still had a discharge from the urethra containing gonococci. He had no fever.

The affected limb was fastened to a splint, and first of all elevated until the next morning, in order to diminish the œdema and to enable a more detailed examination. In this, however, we did not succeed, the circumference yielding on the morning of July 10 the same result. At 8.45 the same morning the congestion bandage was applied to the arm. After an hour the patient had no more pain. To the greatest surprise of the patient, slight passive movements were possible without pain in the wrist-joint and the fingers. At 9.45 the bandage was removed, and reapplied from 10.45 to 2 p.m. In the evening he wore it again from 7.30 to 10.30, and during this time the patient had the first deep, uninterrupted sleep he had had for a long while. Soon after the removal of the bandage the pain came back, so that the patient could not sleep.

In the morning of July 11 the joint again became painful and sensitive to touch. The bandage was worn from 8.45 to 1 p.m. After it was worn for twenty minutes the pain disappeared, but reappeared an hour after the removal of the bandage. Congestion hyperæmia was again maintained from 7 p.m. to 8 p.m. It produced a strong redness, swelling, and heat in the affected limb. The patient had slept from 9.30 to 4 uninterruptedly. There was no pain on pressure; passive movements of the wrist and fingers were possible to a great extent.

July 12 the patient wore the congestion bandage from 11.45 until 9.30 of the following morning. In the meantime it was fastened on a different place. He slept throughout the entire night.

The bandage was again applied without interruption from 5 p.m. July 13 to 11.30 a.m. July 14. Since then pain in the wrist did not appear even in the intervals during which no hyperæmia was maintained, and pressure elicited some pain only in the joint between metacarpus and carpus. The patient commenced to actively move wrist and fingers. Supination was still rather painful, which now was undertaken in a great measure. After the bandage was off for eight hours the circumference of the affected joint was again measured, showing 23·5 centimetres; therefore there was a reduction in spite of the hyperæmia of but 2 centimetres. The diminution of the swelling was also recognizable by the wrinkled condition of the skin. The improvement of the disease progressed steadily, while the time of the hyperæmia was gradually shortened. July 22 we commenced slight massage, which was stopped on the 28th because it left some pain.

August 1 the patient was sent for treatment to the dispensary in the following condition: The circumference of the right wrist is $19\frac{3}{4}$ centimetres (decrease since July 10, $5\frac{3}{4}$ centimetres), and is 1 centimetre larger than the healthy wrist. The swelling, which is still present, feels firm and hard. Pains can be elicited only by strong pressure on the joint between carpus and metacarpus. Active flexion of the hand is almost entirely free, rotation entirely free; extension, on the other hand, is still very limited. The fingers can be bent up to 2 centimetres from the palm and thoroughly extended. In the polyclinic (dispensary) a daily application of congestion hyperæmia for one hour was given up to August 5, and then massage was added, while the hyperæmia was applied only half an hour daily. A few days later the patient withdrew from further treatment and observation. At that time he was entirely free from pain, and could bend the fingers into a fist.

In the actually grave forms of gonorrhœic arthritis the congestion hyperæmia must be maintained a long time—best twenty to twenty-two hours daily. Otherwise no good results are obtained, or the disease decreases but gradually, in which event it leads to stiffening. Rapid and complete cures are only obtained when prolonged congestion hyperæmia produces an intense œdema. The described case illustrates these conditions. Then the patient only improved when we changed from short to long periods of application. At the time I was treating this case I was making experiments with congestion hyperæmia maintained for an hour only.

In a second similar case, though not quite as grave as the former, we had the same experience in a still more decided manner. In this case we achieved success only when we applied the congestion hyperæmia, in a manner practised in the beginning, for twenty-two hours daily. Especially was sleep only obtained when we permitted the patient to wear the bandage throughout the night.

Congestion hyperæmia in these serious forms of gonorrhœal arthritis has never failed me, and its results in regard to rapidity of cure, and especially function of the extremities, are brilliant as compared with all other means I have employed before in this respect. In Kiel these cases were not at all rare, and my teacher, v. Esmarch, used to treat them with plaster-of-Paris casts. Though they were removed as soon as the disease permitted it, ankylosis or bad stiffening was the rule.

I make it a strict rule for all gonorrhœal joints, which become stiff only too easily, to commence with active and passive motions as soon as the painfulness makes this at all possible. Inasmuch as the congestion hyperæmia usually relieves the pain very rapidly, it is frequently possible to commence with the movements an hour after the procedure has been instituted. Splints are utilized only in the intervals when the bandage is not applied. Occasionally they are used with the bandage during the night, when the pain is still intense, and when involuntary movements during sleep aggravate it.

The treatment of gonorrhœal joints with congestion hyperæmia is far superior to other hyperæmizing methods, as, for instance, hot air. I had opportunity to convince myself

of this in the beginning of my experiments. The following case, which I accepted after treatment elsewhere, confirms this view :

32. A girl, nineteen years old, ten weeks previous to admission was suddenly attacked with violent pains in the left wrist, and was treated for it in another hospital for several weeks with hot air. The joint became gradually stiffer, and the sensitiveness did not diminish. She was received at the surgical clinic September 28, 1900. The left wrist was but little swollen, and measured 1 centimetre more than the other. The skin was red, the joint on the dorsal side of the hand very sensitive to pressure. It was in slight flexion, and pronation and each attempt at flexion elicited violent pain. Congestion hyperæmia was used from September 28 to October 27 throughout each day, and this removed the pain in a few days, so that soon passive movements, and later active motions, could be executed. When discharged, the joint could be flexed and extended in a radius of 50 degrees, and actively rotated without pain. The affected limb became usable.

On the other hand, cases of gonorrhœal inflammation of joints which are already chronic, and the sequelæ, especially the stiffening, are usefully treated with hot air. For the stiffening, the orthopædic suction apparatus described in the General Part are, as a rule, more effective, especially the one for the hand for stiffening of the fingers and wrist-joint.

Rarely one meets cases of gonorrhœal inflammation of joints in which the congestion hyperæmia has no influence on the pain, or even increases it in the beginning. I formerly gave the advice to abandon the remedy in such cases, and to replace it by another. Extensive experience, however, has taught me to treat successfully even these cases with congestion hyperæmia. One must here, I may say, steal in. The bandage is applied until it produces pain ; then it is removed for a short time (as a rule, half to one hour), is applied again, etc. Skilful individualization is the thing that helps here so much. As soon as we succeed in producing a pronounced œdema, the pain usually disappears. I believe I have observed that in some of these rebellious cases œdema is produced only with difficulty. Of late, colleagues who are well familiarized with the procedure of congestion hyperæmia, and have achieved success with it, have sent us cases of gonorrhœic arthritis as unsuitable for this method, in which, after a little experimenting, we obtained very quickly the most brilliant result, as, for instance, in the following case :

33. A gentleman, twenty-two years old, became affected January 6, 1905, in connection with a gonorrhœa with a metastasis of the left wrist-joint. Swelling, redness, and painfulness increased rapidly. He was admitted to the Bonn medical clinic, where he was fruitlessly treated with salicylates internally and ointments externally. An attempt was next made with congestion hyperæmia, which, too, failed. After the patient had worn the bandage a few hours he complained of intolerable pains, so that the constrictor had to be removed. The attempt was repeated four times without success. As the general condition became worse, and high fever and numerous chills occurred, further conservative procedures were regarded as futile, and the patient was transferred January 26 to the surgical clinic on the understanding that surgical opening of the joint had become necessary. I placed the patient in the hands of my assistant, Dr. Keppler, specially skilled in the treatment of acute inflammations, in order to make another attempt with congestion hyperæmia.

The patient on admission showed the following local condition: The region of the left wrist-joint was intensely red and swollen, its circumference measuring 23 centimetres, as against 16½ centimetres of the other side. The joint was in position of extension, and was immovable, even in the sense of rotation. Attempts at motion were extremely painful. The palm of the hand had lost its contours. The fingers were swollen by œdema, and stiff in the position of extension. The forearm, too, was red and swollen. In spite of the short duration of the disease, considerable atrophy of the attacked arm had already occurred.

After a few attempts Keppler succeeded in so placing the congestion bandage that it was well tolerated. The patient wore it eighteen hours without interruption. It produced intense œdema and fiery redness of the hand and of the forearm. The patient stated that the pain had not diminished to any great extent, but he himself was surprised that he could make active movements with the wrists and finger-joints without pain.

After the usual elevation the patient could tolerate the congestion hyperæmia without any inconvenience for twenty hours. Now the painfulness disappeared entirely, and healing made rapid progress. As early as February 4—*i.e.*, nine days after the institution of treatment—the patient was discharged completely cured. Both wrist-joints had the same circumference. The joints, which had been totally stiff, could be moved normally, and showed no trace of sensitiveness. During the patient's stay at the surgical clinic he had neither fever nor chills.

On the affected arm the early symptoms of acute neuritis could be plainly discovered. All nerve-trunks were very sensitive on pressure. It is possible that this neuritis was the cause of the increase of painfulness, first observed under the pressure of the constrictor; for it was striking that the patient did not locate the pain in the inflamed joint, but throughout the entire arm below the bandages, and especially at the place of constriction. It is possible that a neuritis has frequently been the cause for the failure of congestion therapy in gonococcal joints; for it is just as possible for the gonococcal toxin to damage the nerves as any other tissues. It is worth while, therefore, to watch in such cases for neuritis.

I have recently seen other cases in which congestion therapy was successful in our hands after others had failed with it. I must therefore withdraw the advice given by me some time ago, to abandon it when success is not noticed at once, but must change it to the advice to try in this or that way to achieve success, and, it seems, success is certainly to be had. To achieve this, of course, is a matter of personal skill.

I usually admit such rebellious cases to the hospital.

Very recently my observations on the surprisingly favourable effect of congestion hyperæmia on gonococcal joints have been confirmed in diverse quarters. The first to report on it was Habs,[1] who was followed by Luxembourg,[2] Bum,[3] Tillmanns,[4] v. Tiling,[5] Laqueur,[6] Hirsch,[7] v. Leyden and Lazarus,[8] and others. They all reported favourable results. Above all, my statements about the anodyne effect of our remedy have been confirmed by them. At the same time, I am under the impression that these authors have not applied the congestion hyperæmia energetically enough and long enough each day; for successes as complete and *rapid* as I have seen in fresh cases—to which, for example, the case described under No. 33 belongs—are reported by v. Tiling only. An example of how congestion hyperæmia should not be applied is presented by Hirsch's contributions. The congestion hyperæmia used by that physician, "at first only a few minutes, then gradually increasing to half to one hour, rarely to one and a half to two hours, and in one case only to three hours," cannot be of much use. I am sure I have emphasized that often enough. I am only

[1] Habs, "Über d. Bier'sche Stauung" (*Münch. Med. Wochenschrift*, 1903, No. 22).

[2] Luxembourg, "Über Bier'sche Stauung" (*Münch. Med. Wochenschrift*, 1903, No. 10).

[3] Bum, "Die Behandlung von Gelenkerkrankungen mittels Stauung" (*Wiener Med. Presse*, 1905, Nos. 3 and 4).

[4] Tillmanns, "Über Behandlung durch venöse Stauung" (*Deutsche Med. Wochenschrift*, 1905, No. 4).

[5] v. Tiling, "The Treatment of Gonorrhœal Arthritis by Hyperæmia" (*Journal of the American Medical Association*, April 29, 1905).

[6] Laqueur, "Zur physikal. Beh. d. gonorrh. Gelenkerkrankungen" (*Berliner Klin. Wochenschrift*, 1905, No 23).

[7] Hirsch, "Über d. Beh. d. Arthritis gonorrhoica mit Bier'scher Stauung" (*Berliner Klin. Wochenschrift*, 1905, No. 39).

[8] v. Leyden and Lazarus, "Über d. Beh. d. Gelenkentzündungen mit d. Bier'schen Stauungshyperämie" (*v. Leuthold-Gedenkschrift*, vol. i.).

astonished that he has, in spite of that, obtained relatively good results. His technique calls for objections in other respects, too.

Is it not a remarkable thing that, since my first publication in 1894, it has taken fully nine years before so simple a remedy, strongly recommended by me again and again, has been subjected to a test ? It seems that this has been tried only since the publication of Habs. I am very grateful to Habs, for I would not have been believed yet. I do not mention this to complain. But the thing seems characteristic to me of the modern tendency for fashions in medicine. Simple and logical remedies are ignored, but such produced according to " all rules of science " in laboratories and factories are incredibly overestimated and disseminated. How much excitement would it have created if some serum for injection or some chemical preparation, thrown on the market with some attractive name, could have achieved similar results in so terrible and so intractable a disease, therapeutically, as is represented by a joint gravely attacked by gonococcal infection ! As proof for this, I select Menzer's antistreptococcus serum. Within three years of its discovery, considerable literature on the remedy had accumulated, and it was extensively used. And yet, according to reports, if it is useful at all, it cannot even begin to compare with the efficiency of the congestion bandage.

It cannot be denied that the effect of a serum is a biological and scientifically interesting process. For both remedies, serum and hyperæmia, after all, are only supporting a natural healing process ; therefore they stand on the same level, and are of equally great theoretical significance. The only difference is that the former is produced in a very complicated manner, while the latter can be produced in a simple manner by any surgeon. But simplicity should always recommend a remedy.

I say this in discussing gonococcal and not tuberculous joints, because I fully understand that in the latter the congestion hyperæmia has been rejected by many on account of harmful results. For tuberculosis is a very chronic disease, and the technique of treatment, as I at first recommended it, was difficult and uncertain, it having been

gradually developed. But in gonorrhœal joints success appears immediately, and, apart from a few rebellious cases, congestion hyperæmia is easily produced and maintained.

I have treated with similar results also other forms of acute arthritis by means of congestion hyperæmia. In acute articular rheumatism—of which, certainly, I have treated only about ten cases—all patients stated that the pain disappeared rapidly after the application of the congestion bandage. The joints which had been subjected to congestion hyperæmia also showed a more rapid retrogression of all other disease phenomena than those, equally strongly attacked, which had not been so treated. However, the number of cases is so small that, in so changeable a disease as acute articular rheumatism, where one day the joints appear seriously affected, only to appear quite free the next day, positive conclusions cannot be drawn. The method of treatment is the same as that for gonorrhœal arthritis.

v. Leyden and Lazarus[1] have recently described cases of acute articular rheumatism which, on the whole, have been favourably influenced by congestion hyperæmia. Certainly they have also administered internal remedies, and they stated that attempts to treat acute articular rheumatism with congestion hyperæmia only have yielded no results.

But in all other forms of acute, and especially subacute, inflammation of joints I have seen the best results with treatment by congestion hyperæmia. I have succeeded in curing with it two cases of intense puerperal inflammation of the knee-joint without suppuration, which had persisted for weeks, and with good functional result. This means a good deal, for, as a rule, these joints become stiff.

Treatment of Large Suppurating Joints with the Congestion Bandage.

I have already reported that I have seen suppurating joints heal rapidly and with good mobility, after aspiration and irrigation, by means of congestion hyperæmia. In the first edition of this book I described a traumatically

[1] *Loc. cit.*

suppurating joint, communicating with an open wound, which was cured in twelve days by congestion hyperæmia solely, without any other measures whatever. I have extended this treatment of suppurating joints, and in order to obtain pure observations have abstained from using any other remedies in a series of cases. Joints which had sinuses or open wounds were moved passively every day, with the intention of evacuating the pus. Sinuses or wounds were neither enlarged nor drained. If we had to deal with a closed abscess of the joint, diagnostic puncture with a hypodermic syringe was made, in order to establish the diagnosis and the pus-producing germ. Otherwise the pus in the joint was let alone. I have also avoided fixation by splints. Congestion hyperæmia *only* was resorted to. The following cases, therefore, offer doubtless proof.

These cases, which we will describe, concerned elbow- and knee-joints. Their treatment—to resume again briefly—proceeded as follows : Patients with stiff knees were simply put to bed. Arms whose elbow-joints were suppurating were placed, while the patients were up and about, in a sling (mitella), and conveniently rested in bed when the patients lay down. Any kind of fixation was avoided ; the anodyne effect of congestion hyperæmia permits the avoidance of fixation. If a sinus or wound communicated with a joint, on account of the profuse discharge characteristic of these joints it was provided with a *very loosely applied* but voluminous sterile dressing, which allowed the joint to swell under the influence of congestion hyperæmia, and the patient to make motions of the joint. Careful active and passive motions were made a few hours after the institution of congestion hyperæmia. This, too, is made possible by the anodyne effect of the remedy. As a rule, the patients themselves were astonished to find that the violently painful suppurating joints could be moved. During this manipulation large quantities of pus flowed out. In these cases, therefore, passive motion is the best remedy for removal of the pus. Certainly these motions must never become violent. They should be undertaken only to an extent which will not produce any inconvenience to the patient. In addition, he is admonished to actively move the joint.

I am aware that I find myself, with my recommendation of motion of acute suppurating joints, in sharp opposition to one of the most recognized surgical axioms; for it has been taught again and again that to place them at rest is the supreme law of treatment. I am also confident that without congestion hyperæmia applied at the same time as exercises were used would be followed by an aggravation of the disease. But I had long ago recognized in gonorrhœically and pyæmically diseased joints that congestion hyperæmia very quickly admits extensive movements, so that I could fearlessly apply them also to acute suppurating joints. I must confess that I myself was at first astonished to observe how well the patients tolerated motion. The usefulness of this procedure is very evident. It is certainly known that acute suppurating knee-joints, especially in young individuals, very frequently heal with motion after aspiration and irrigation. In such cases we have, as a rule, metastatic suppuration or collateral inflammation of joints (especially in acute osteomyelitis), in which the pus is occasionally found to be sterile. But it is also just as well known that joints attacked by serious infection, especially when this is due to external injuries, fairly regularly become stiff or ankylosed, and that it is looked upon as success in treatment when the diseased extremity heals in that condition. Congestion hyperæmia associated with early movements, however, has enabled us to achieve even in the gravest forms of suppuration of joints complete function without the slightest limitation.

34. A cottage worker, eighteen years, contracted three weeks prior to admission an injury of the right elbow-joint. The external wound healed, but the joint suppurated beneath it, for which reason the joint was incised at a foreign hospital. Then the joint was treated with baths. The patient entered our hospital December 22, 1903.

The right elbow-joint was swollen, the skin œdematous. It stood in right-angled flexion and in pronation. Further extension, flexion, and rotation in the sense of supination, could be made only to a limited extent, and that with great pain. At the outer side of the joint was a granulating place as large as a finger-nail, somewhat below a sinus, from which turbid synovial fluid was evacuated by pressure on the joint. There was but slight rise of temperature, the highest temperature (except an incident which will be described at the end of this work) being 38° C. in the axilla. The joint was treated with congestion hyperæmia.

The patient was discharged cured February 24, 1904. The swelling of the joint had gone down, there was no pain, flexion and extension were possible almost normally Rotation was entirely free.

35. A stonebreaker, eighteen years, was stabbed in the elbow-joint during an altercation May 25, 1904. He became infected. He was admitted June 11, 1904. The left elbow-joint was very much swollen, red, and œdematous. It stood in almost rectangular flexion, and could be moved actively and passively only to about 15 degrees in the sense of flexion and extension with pain. At the radio-humeral joint was a round opening, from which protruded a granulation plug the size of a hazel-nut. Attempts at passive motions caused the flow of a large quantity of pus from the opening. The affection was so painful that the patient could not sleep during the night. Bodily temperature was normal. Congestion hyperæmia was at once instituted. July 2 the sinus was closed and swelling of the joint gone. Congestion hyperæmia was therefore discontinued, and the patient treated with passive motions only. He was discharged July 12. All motions of the joint were free, complete extension slightly restricted. August 9 the patient presented himself with an entirely normal joint. He has resumed his hard work as stonebreaker, and does it without any hindrance.

36. A farmer, twenty-six years, contracted, February 4, 1904, in connection with an injury, suppuration of the right elbow-joint. February 25 his physician made an incision 3 centimetres long, and evacuated pus. Active and passive motions were possible only to a very slight extent, and

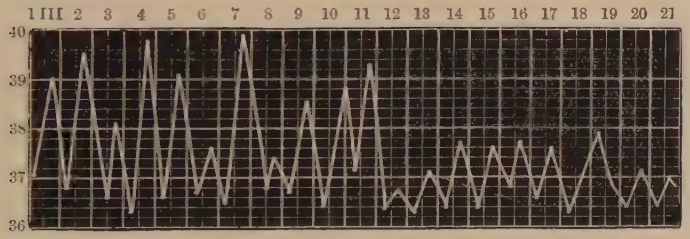

Chart VI.

with intense pain. The joint was fixed in rectangular flexion. The patient had a pronounced remittent temperature, which started every evening with chills (see Chart VI.). Congestion hyperæmia was applied. The joint sinus closed very soon, mobility became more free, temperature sank to normal, and the dirty ulcer became healthier. Since March 23 the constrictor was discontinued. The patient remained in the hospital until April 26, in order that the large ulcer might be covered with skin, and to practise active and passive movements of the joints. On discharge the affected joint was no thicker than the healthy one, and almost completely mobile. The patient was seen again on May 10. Flexion of the joint was perhaps slightly restricted, but apart from this it was movable to the greatest extent and completely useful. With the exception of a scar and slight friction in the joint on rotation, there was nothing to indicate the previous disease.

These cases of suppuration of the joint communicated externally by means of sinuses, and satisfied, though in an imperfect manner, the old surgical demand that pus must invariably have an outlet. The two following cases, however, show that congestion hyperæmia can transform hot

abscesses of joints into cold ones, and then cause their disappearance in the manner explained above.

37. A boy, three years, four weeks prior to admission injured himself with a wood splinter on the outer side of the right knee-joint. Soon afterwards the joint swelled, with phenomena of fever, and assumed the position of flexion. He had been painted with tincture of iodine.

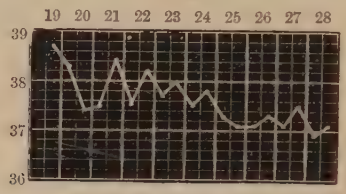

Chart VII.

The patient entered our hospital November 19, 1903. The right knee-joint was swollen like a ball, felt hot, fluctuated, and was painful. The patella "floated." Swelling was considerable, measurements at different places showing an increase of $2\frac{3}{4}$ to 5 centimetres, as compared with the healthy sides. The joint was flexed in an angle of 115 degrees, and was almost completely fixed. But a trace of further flexion was possible. Aspiration with a hypodermic syringe revealed pus containing a pure culture of staphylococci. The course of temperature can be seen in Chart VII. The small wound of the joint made by the wood splinter had healed long ago.

A congestion bandage was immediately applied, and worn at first nineteen to twenty-two hours, later gradually less, finally two hours daily. Mobility increased rapidly, and the effusion diminished considerably. The bandage was discontinued November 25. Twenty-seven hours later it was demonstrable that a considerable effusion in the joint was still

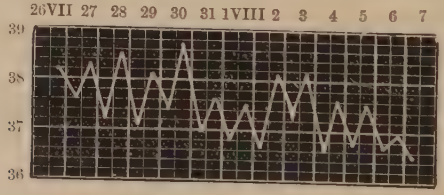

Chart VIII.

present. The latter, however, was movable to almost its full extent. Congestion hyperæmia was reapplied one hour daily, but as a rise of evening temperature to 38° appeared on November 30, the bandage was again worn twenty to twenty-two hours daily.

The boy was discharged December 20. The joint was normally movable to the greatest extent and useful, but measured in circumference $\frac{1}{2}$ to $\frac{3}{4}$ centimetre more than the healthy one. The effusion had completely disappeared, the slight swelling being due to thickening of the capsule.

38. A locksmith, twenty years, became suddenly ill July 4, 1904, with an acute inflammation of the right ankle-joint. The disease jumped from

one joint to another, and finally remained stationary in the right knee-joint, which became violently affected six days prior to admission.

He was admitted July 27, 1904. The right knee-joint was enormously swollen, and had a circumference $6\frac{3}{4}$ centimetres more than the healthy one. The entire thigh was œdematous, the skin traversed by dilated veins. The joint was in the position of extension (it had been previously fixed with splints), and was extremely sensitive. The patient yelled when in contact with the bed-clothes. Any attempt at motion was out of the question. Aspiration with the hypodermic syringe yielded pus, which showed staphylococci microscopically and by culture.

Congestion hyperæmia was immediately instituted. It cost some effort to find the right degree of hyperæmia. After this was achieved, four days of application sufficed to practically remove the pain. After twelve days of treatment temperature returned to normal, the patient having had a rigor August 3. August 10 the patient could flex the knee to a right angle. Effusion in the joint was still considerable, but aspiration with the hypodermic syringe produced only turbid serous liquid. Congestion hyperæmia was applied from August 10 only two hours daily. The patient rose August 15, though a slight effusion in the joint was still present, which soon disappeared. The man later on acted as orderly in the hospital. Suppuration of the joint left not the slightest trace. Chart VIII. shows the course of the temperature.

These five cases of pronounced suppuration of large joints have all healed with complete function, solely by the use of congestion hyperæmia without any other remedy, especially without the slightest operative procedure. Truly a proud success, which requires no further illustration! Of late I have had a series of similar cases. Our results were the worst, as far as function is concerned, where we had to deal with burrowing of osteomyelitic pus into neighbouring joints. Here we obtained complete cures even in the matter of function, but also in some cases severe stiffening.

I do not desire it to be supposed that I wish the pus to remain in the acutely inflamed joints, as a matter of principle. It is obvious that I should aspirate and irrigate or incise the joints if the favourable effect of the congestion hyperæmia were not very quickly established, and I have done so in several cases. But I avoid as much as possible drainage and tamponade of the joints, because the joint is a fine mechanism which does not tolerate well such crude intervention, and easily reacts with lasting injury of function. The majority of surgeons are very modest in this respect; they are satisfied when suppurating or tuberculous joints "heal" more or less with ankylosis—one could say become crippled. I hope that congestion hyperæmia will produce a change of things for such cases.

Here too, I repeat, the question of aspiration or incision of

the abscess is entirely independent of congestion hyperæmia. According to my experience, however, a joint is the part of the body from which hot abscesses readily disappear under the influence of congestion hyperæmia, without requiring incision.

I only remark that I have cured a whole series of suppurating finger-joints with congestion hyperæmia rapidly and with full function. These cases, however, do not prove as much as the suppuration described of large joints; for I have formerly seen healing of these small joints frequently without congestion hyperæmia, after simple incision. I wish to add that several such small joints required prolonged congestion hyperæmia in order to heal perfectly.

The good results of congestion hyperæmia in acute inflammation and suppuration of joints have recently been confirmed by diverse physicians.

Treatment of Phlegmons of Tendon Sheaths with Congestion Hyperæmia.

The best test of the efficiency of congestion hyperæmia is the phlegmon of tendon sheaths. To be sure, we occasionally succeed with our usual treatment—with long or several short incisions, drainage, tamponade, and elevation—in so curing *incipient* phlegmon of tendon sheaths that not only are the tendons preserved, but more or less satisfactory function, or even complete restoration, is achieved. Such cases, no doubt, have occurred in the experience of any up-to-date surgeon. But, as is well known, this favourable termination is not the rule, not even in incipient phlegmons of this kind. If, however, the disease has existed for days, if the pus has burrowed from the tendon sheath into the vicinity, or *vice versa*, we practically never succeed in saving the tendon from death and the concerned extremity from grave permanent mutilation. I at least have not observed, throughout my whole life, that such a tendon has been preserved, although I have tried treating it at first with large and then with short multiple incisions. The condition is different, however, with congestion hyperæmia.

I briefly repeat the principles upon which we treat such infections.

Just early phlegmon of tendon sheaths, whether an injury

lead into the tendon sheath or not, are at first not operated upon at all; but the attempt is made to control it in birth by the immediate institution of intense congestion hyperæmia. If this is not successful, or if a large accumulation of pus is undoubtedly present, the abscess is opened with one large or several *small* incisions. I avoid the very large incisions, occupying the entire extent of the tendon sheath, because there is the danger of the tendon jumping its bed, losing connection with the surrounding soft parts, drying up, and suffering death. For the same reason I abstain from any form of drainage and tamponade. Tamponade especially, because of its absorbing property, withdraws from the tendon its nutritive juices, causing its desiccation. If the wound is left to itself, the exposed tendon is soon covered by granulations developing laterally. The pus is squeezed out every day through the small incisions, and, if need be, irrigation with physiological saline solution is practised. Newly developed abscesses are incised. To insure thoroughness, all operative procedures are made under anæsthesia. Sudeck's excellent ether "intoxication" renders here good service. A splint is not worn. If there has been a previous operation, the wound is simply covered with ample dressings, because congestion hyperæmia, as a rule, produces profuse discharge. The dressing should be applied loosely, to enable the part beneath it to swell subsequent to congestion hyperæmia, and the patient to make movements with it. The above-mentioned towel dressings are best. On the first day the physician makes daily passive motion of the fingers (for these are almost exclusively attacked). The fingers are flexed and extended in all joints. In this manner only do we succeed in getting fingers with good function. Occasionally the tendons are glued to the surroundings, even after twenty-four hours. These are loosened during the motion exercises, giving a creaky sound. The procedure, which under other circumstances would be harsh, is relatively well tolerated under congestion hyperæmia, because of its prominently anodyne effect. Certainly one must never use great force. I have never observed spreading of suppuration, which one would naturally fear from it. The congestion bandage is to be removed some time before the institution of passive motions, to prevent bleeding of the

granulations. The exercises are best made in the intervals between two congestion periods. In addition, the patient is admonished to actively move the fingers.

In only one case of incipient phlegmon of the tendon sheath that I treated, which was plainly suppressed by congestion hyperæmia, did the movements have a bad effect (Case 40). In this case we were compelled to resort to fixation, which produced improvement in a few days. The rule just given, therefore, has exceptions. One should never treat by rigid rule.

I quote, to begin with, three cases where we succeeded in suppressing a phlegmon of the tendon sheath in its incipiency :

39. A butcher, aged forty-three. November 2 he sustained a wound 2 millimetres wide across the small finger of the left hand. He worked with it up to November 5 without paying attention to the wound. It finally became inflamed, and the patient called three times on a physician, who incised it each time. November 11 he came to the hospital because the condition got suddenly worse after the last incision. On the flexor side of the small finger, in the region of the second part, was found a cross wound in which a tendon was exposed. The entire region of the flexor tendons of the small fingers was extremely painful to touch up to the wrist. If we pressed over the sheath of the flexor tendon from the wrist-joint towards the wound, a discoloured, watery liquid appeared at the wound. The ulnar part of the skin of the region of the wrist and 3 centimetres upwards was very red and sensitive to pressure. The joint between the first and second part of the little finger was open. We discovered an extensive lymphangitis of the forearm and swelling of the cubital gland. General condition was bad, pain severe. Immediately while in the dispensary, before even being admitted to the hospital at 11 a.m. of the same morning (November 11), a congestion bandage was applied to the arm, while the patient had a temperature of 39° C., taken in the axilla. It cost a considerable effort to produce the right kind of hot congestion hyperæmia without also producing pain. When this was attained the pain soon disappeared. The painful and stiff little finger could now be bent by the patient. The congestion hyperæmia was continued to 4 p.m., then removed. As this was all done previous to admission, no exact record of his temperature was obtained.

After removal of the congestion bandage pain reappeared quickly. At 6.45 p.m. patient had a chill. The bandage was then reapplied. Again the right hot congestion without pain was obtained after great effort and difficulty. After this was attained the pain disappeared rapidly, the temperature sank at 8.30 p.m. to 38° C., and at 10 p.m. was 38·7° C. At 10 in the evening the bandage was removed for a short while, then reapplied and worn until 4 a.m. When the congestion œdema became somewhat lessened it could be seen that the swelling and redness at the wrist had disappeared, as also the lymphangitis. Only the region of the flexor tendon of the small finger was still sensitive.

November 12 the congestion bandage was worn from 9 to 1, from 5 to 8.30, and from 10.30 p.m. to 10 a.m. of November 13. After this the disease was essentially removed, the swelling had diminished, only some sensitiveness remained in the above-named place. With

increasing intervals the congestion hyperæmia was continued to November 15. The temperature did not rise November 12 over 38·6° C., November 14 not over 37·7° C., and was normal from November 15. Small superficial tendon shreds were expelled from the wound,[1] which healed quickly. The suppurating joint remained somewhat stiff, and had crepitations on motion, but on the whole the disease was removed without any disturbance of the function of the hand.

40. A servant-girl, nineteen years, noticed on November 21, 1904, pain in the small finger of the right hand. November 23 the trouble became aggravated, and was ushered in by a chill. The girl was admitted November 24. The small finger of the right hand was swollen throughout, and in the position of flexion. Every attempt at extension produced intense pain. The flexor tendons were sensitive to pressure up to the middle of the hand. The flexor bend of the small finger showed a small fissure. I considered the disease to be an incipient phlegmon of the tendon sheath, and immediately instituted congestion hyperæmia with the intention of suppressing it. The phenomena of inflammation soon retrogressed, the temperature sank to normal (see Chart IX.), and congestion hyperæmia was discontinued as early as November 30. The small finger showed an inclination to remain flexed, for which reason energetic passive movements were practised. December 4 the pain returned, congestion hyperæmia was again resorted to, and owing to the inclination of the finger to become stiff the energetic passive motions were continued, without, however, improving the mobility. On the contrary, the small finger became stiffer

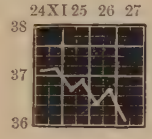

Chart IX.

and stiffer; the other fingers, too, assumed the position of flexion, and pain reappeared. There appeared a hard, cord-like swelling, corresponding to the course of the flexor tendons of the small finger.

December 11 the pain became considerably worse. Examination showed that the entire tendon sheath apparatus concerned in panaris of the tendon sheath of the small finger was diseased. The flexor tendon sheath of the small finger was very sensitive to pressure, that of the thumb and the great general synovial sac at the wrist-joint less so. The skin above the wrist-joint was red, bodily temperature slightly elevated.

For this reason I made an incision 4 centimetres long under ether, exposing the tendon sheath of the flexor of the small finger in the palm. It was tensely filled with liquid. On incision a large quantity of slightly turbid liquid was evacuated. On pressure on the common synovial sac, two teaspoonfuls more of the liquid were evacuated. I allowed the wound margins to fall together, and it healed in a few days by first intention.

Microscopic examination of the liquid showed a small amount of leucocytes. No bacteria were found. Cultures made at the Bonn hygienic institute showed that the fluid was sterile.

Passive movements were continued, but again produced considerable pain, for which reason the hand was fastened to a board from December 16 to 20. After this the trouble soon disappeared. The swelling of the

[1] I have observed three times that under congestion hyperæmia the tendon expelled a small partial sequestrum, but otherwise remained intact, a thing I have never observed before.

tendon sheath apparatus went down ; strong pressure only elicited slight pain, which, too, disappeared December 23. The patient was admonished to diligently make active movements. Passive movements were practised only with great care. The mobility of the fingers increased more and more. The affection healed without a trace of disturbance of function.

41. A girl, ten years, was struck, March 29, 1905, in the left hand with a dirty pitchfork, thrown at her by a labourer. The hand was dressed half an hour later in the Bonn polyclinic. Severe pain developed, and she passed a sleepless night. For this reason she was admitted to the hospital March 30.

The following status was found : The entire left hand and the adjoining lower half of the forearm is intensely red and swollen. At the ulnar side of the wrist is a wound the size of a pea, produced by the pitchfork. The left hand is anxiously spared and supported by the right. The fingers are very much flexed, and every attempt at extension causes extreme pain. Pressure on the palm is not painful, but pressure on the region of the tendon sheaths above the wrist-joint shows extreme sensitiveness. The region of the flexor tendons of the thumb is not painful. The wrist-joint is intensely swollen and very sensitive to pressure. Bodily temperature is elevated (see Chart X.).

The swelling and pain of the hand-joints, the rigid position of flexion

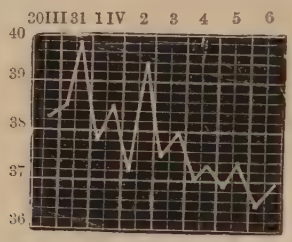

CHART X.

of the four last fingers, and the sensitiveness of the concerned tendon sheaths, led me to diagnose an infection of the latter and of the wrist-joint, and I instituted congestion hyperæmia about thirty-four hours after the injury.

Half an hour later the child could extend a little the previously stiff fingers, had no pain, and slept quietly. The following morning it was observed that the congestion bandage had produced a fiery œdema of the part of the extremity peripheral to it. April 1 the temperature was lower, and the wrist-joint was somewhat movable ; but as the temperature rose again the following day, and I ascertained that after elevation during the intermission of the congestion hyperæmia the region of the flexor tendon sheath of the small finger and the great common synovial sheath remained fiery red and sensitive, I suspected suppuration of these structures. The following day, on removing the scab which had formed over the site of the injury, a little pus appeared. Pressure on the flexor tendon sheath of the small finger and on the common synovial sheath produced a flow of pus. The probe led in the region of the wrist-joint to rough bone, and beneath the flexor tendons, up to above half of the forearm.

I made an incision 4 to 5 centimetres long above the wrist-joint under ether intoxication. It led into a pus cavity in which flexor tendons were exposed. The cavity led between the muscles upwards to almost half the forearm. Downwards the probe went into the flexor tendon sheath of the small finger. This was opened by a second incision 3 to 4 centi-

metres long, from which was evacuated thick pus surrounding the tendons. The common synovial sac was reached from the incision, which also was filled with pus, and in which the concerned tendons were exposed. Though, according to this exploration, the wrist-joint, too, appeared to be suppurating, I decided not to open it for the time being. The pus was thoroughly irrigated with physiological saline solution. I only covered the wound with an aseptic dressing, and again instituted congestion hyperæmia. Healing now progressed rapidly, so that the hyperæmia could be discontinued April 15. The tendons did not become necrotic. The child was discharged April 30 with full mobility of all fingers and of the wrist. I have since repeatedly examined the child. The grave phlegmon has healed without a trace of disturbance of function.

Chart X. shows the course of the temperature.

As a general rule, such complete cures as the ones here described are naturally only possible when the disease is still fairly recent. The main thing, therefore, is early diagnosis. Then only the probability exists of saving the attacked tendons from death. This is plain enough, for what is dead cannot be revived by any remedy in the world. Nevertheless, we have succeeded several times in saving the threatened tendon in long-standing phlegmon of the sheath. I cite an example of this:

42. A shoemaker, thirty-four years, suffered for four weeks from a whitlow of the right index which had been incised several times. A few days before admission the flexor tendon sheath, which contained pus, was opened by an incision 2 centimetres long at the proximal phalanx. As there was no improvement in spite of this, the patient entered the hospital February 14, 1904.

Shortly after admission he had a chill, the general condition was bad, the finger was very painful, red, and intensely swollen. Congestion hyperæmia was instituted, which at once removed pain and the bad general condition; but the increased temperature remained, and on February 16 pronounced pain reappeared. Pressure over the course of the flexor tendon evacuated much pus. February 19 it was clear that a large abscess of the palm had formed. For this reason the patient was anæsthetized and the old wound separated. In its depth the flexor tendons were found free. The abscess of the palm could be partially removed through this wound by pressure. The abscess was opened by an incision 2 centimetres long. A large amount of thick pus was evacuated. The wound led into a cavity which extended upwards to beneath the ligamentum carpi volare, and between the metacarpal bones of thumb and index almost to the skin of the dorsum mani. New tendon sheaths, however, did not seem attacked by suppuration. Healing now progressed rapidly. The patient was discharged May 2, 1904, with superficially granulating wounds. The tendons did not become necrotic. The patient was again seen at the end of May. Active mobility of the finger was approximately normal, so that the patient could make good use of it in his work as shoemaker.

In addition, I will describe two instructive cases of gravest V-shaped phlegmon of the flexor tendon sheaths of the hand which I treated with congestion hyperæmia:

43. A locksmith, forty-nine years, was attacked four weeks prior to admission with a superficial panaris of the index and small fingers of the left hand. Both healed rapidly. Fourteen days preceding admission an abscess of the palm developed, which was opened by his physician with two small incisions. February 18, 1904, the affection became considerably worse, for which reason the patient entered the hospital February 19.

The entire left hand was intensely red and swollen. The course of the flexor tendons of the thumb and of the small finger was especially swollen, and very sensitive to pressure; also the flexor side of the forearm above the wrist-joint. The entire forearm up to the elbow was intensely red and œdematous.

Incision was made first above the ligamentum carpi volare, the patient being anæsthetized. When the tendon sheaths were reached they were found to be filled with serous pus. Next, the flexor tendon sheath of the small finger was incised, and showed the presence of thick, creamy pus. A third incision at the ball of the thumb led into a large abscess cavity in which the flexor tendons of the thumb lay loose. A slender dressing forceps which was introduced in both of the above-mentioned wounds appeared through the wound above the wrist-joint. The pus was carefully irrigated with physiological saline solution. Congestion hyperæmia was instituted. This was followed by an extremely bad smelling suppuration of the operation wounds, which gradually decreased more and more. March 20 all wounds were closed without the appearance of necrosis of the tendons. The patient was discharged at his request March 24. Active movement of all fingers was present, but fairly restricted. The fingers could not be completely clenched into a fist when he presented himself again in November, but otherwise they could be well moved actively. Passively every individual joint could be moved to the fullest extent. The man continued his work as locksmith. He could not do very delicate work. I saw him again in March, 1906. He has almost completely regained the full function of his hand, and though it is not as good as before, it had nevertheless steadily improved, so that, no doubt, the rest of the function disturbance will yet disappear. The fingers were movable actively as well as passively in normal limits.

44 A musician, forty-one years, injured the distal joint of the right thumb February 13, 1904. During the following night a violent inflammation developed, and he had chills. A physician made a small incision a few days later. The patient was admitted February 20 with chills.

The right hand and the right forearm were intensely swollen and red. The dorsum mani had a tense œdema. Numerous lymphangitic streaks ran up to the axilla. The skin of the thumb looked partially bluish, partially greyish-red, and was suspicious of gangrene. At its distal joint was an incised wound 2 centimetres long. The region of the flexor tendon of the thumb and of the small finger, and a swollen place above the wrist-joint, were very sensitive to pressure. The flexor tendon sheath of the small finger and thumb in the bend was opened under anæsthesia by an incision 3 centimetres long. A third incision 5 centimetres long opened an abscess above the flexor side of the carpal joint. Thin, dirty pus was evacuated from all three incisions. From the upper incision the finger reached 6 centimetres deep into a pus cavity, which led between the deep muscles of the forearm. The pus was squeezed out through the incisions as much as possible, and washed out with physiological saline solution. After evacuation of the pus a thin, dirty-looking liquid flowed from all wounds. The subcutaneous cellular tissue was discoloured yellowish-grey. No granulations were found. The pus contained staphylococci. Congestion hyperæmia was instituted. Profuse suppuration followed. I opened the wrist-joint February 25 by a small incision at the radial and ulnar side, because the temperature was high and painfulness and swelling remained.

Motions forced thick pus through these incisions. February 27 I had to again open two large abscesses which developed between the muscles of the forearm. The skin of the back of the hand was everywhere undermined and elevated.

The wounds gradually became clean, but the tendons became necrotic and the wrist ankylosed. The patient was discharged April 16, 1904. Elevated temperature had persisted up to March 17.

The patient presented himself November 3. The hand showed the same sad picture we are accustomed to see after such grave, crossed phlegmon of the tendon sheaths. Congestion hyperæmia had made no change.

When I wrote the third edition of this book, I had treated 25 cases of phlegmon of tendon sheaths ; in but 8 of these did the tendons become necrotic. Now the number of our cases has been increased by 11. Among these there was but 1 which led to necrosis of the flexor tendons of an index-finger. Altogether, therefore, we treated 36 cases, 9 of which terminated with necrosis of the tendons. It is noteworthy that our results became gradually better with increasing experience. We cured without necrosis—previous to the last failure—15 consecutive cases, 4 of which were grave and progressing.

Among the nine cases which terminated unfavourably, the beginning of the disease dated back in one case over a month, twice fourteen days, once twelve days, once ten days, once eight days, once seven days (grave V-shaped phlegmon) ; and once the injury which caused the phlegmon was only two and a half days old. Once the patient could not state the time, because he suffered from syringomyelia, the painlessness produced by this disease having caused him to fail to recognize the beginning of the trouble.

Several of the cases terminating unfavourably were complicated by panaris of the bones and joints.

More than half of these cases had positive necrosis of the tendons when our treatment was instituted.

The excellent results have been confirmed by many, as by Croce,[1] Stich,[1] Danielsen,[1] Bardenheuer,[1] Jerusalem,[2] Ranzi,[3] and many others. Bardenheuer comments as follows : " The results in phlegmon of the tendon sheaths are truly brilliant, and if the method accomplished nothing

[1] Transactions of the Thirty-fifth Congress of the Deutsche Gesellschaft f. Chirurgie, pp. 220-266.

[2] Jerusalem, " Bier'sche Stau- w. Saugbehandlung in der Kassenpraxis " (*Wiener Klin. Rundschau*, 1906, No. 23).

[3] Ranzi, " Über die Behandlung akuter Eiterungen mit Stauungshyperämie " (*Wiener Klin. Wochenschrift*, 1906, No. 4).

more than that, it would deserve not to be forgotten." Lindenstein[1] reports bad results in phlegmon of the tendon sheath. He preserved the function of the tendon but once in eleven cases. He reports that, "in spite of extensive incision and congestion hyperæmia," the tendons became necrotic. Possibly they became so *because* of extensive incision. My results, at any rate, lead me to adhere to my small incisions. To be sure, one should always incise, and especially early.

If we recall the miserable results of our operative and antiphlogistic treatment of phlegmon of tendon sheaths, any competent surgeon will admit that the results given above have not been achieved hitherto elsewhere, and that they must be regarded as brilliant.

The failure is disheartening in the fresh case, where the injury from which the disease developed was but two and a half days old, the phlegmon, therefore, having existed but a short time. I will report the clinical history, and we will attempt to see whether a technical error is responsible for it.

45. A male servant, twenty-four years, sustained a contusion in the night from October 2 to 3, which was followed by an inflammation of the right middle finger. A physician made a small incision, which, however, did not remove the trouble.

The patient was admitted October 5, 1904. The right middle finger was swollen and red. An incision 1½ centimetres long had been made between the end and middle joints, which, however, was deep only in its middle. Pressure over the tendon sheath forced out pus.

The attempt was made to suppress by congestion hyperæmia the phlegmon of the tendon sheath without any other incision, but suppuration increased considerably. An abscess broke through the flexion fold between finger and hand, and another abscess communicating with the former broke through the skin of the back of the finger. For this reason the tendon sheath at the proximal phalanx was incised (October 9) up to the palm, and the abscess at the back of the finger, too, was incised. Congestion hyperæmia was continued. The tendons became necrotic, for which reason the finger was exarticulated October 27.

It seems to me the tendon sheath was not incised early enough. The incision made by the former attending physician was only a superficial division of the skin, therefore useless. There was in addition considerable contusion of the tissues. Soon after the institution of the congestion hyperæmia, blisters formed, the colour of the

[1] Lindenstein, "Erfahrungen mit der Bier'schen Stauung" (*Münch. Med. Wochenschrift*, 1906, No. 38).

finger became bluish, while as a rule it appears red in acute inflammation.

Apart from this, I have seen two cases of recent inflammation of fingers retrogress without operation after congestion hyperæmia, which, according to the physical examination, in all probability were cases of incipient phlegmon of the tendon sheath. I have not included them in this review because I lacked the necessary proof for the diagnosis. According to our experience with other forms of suppuration and inflammation, it is probable that recent phlegmons of tendon sheaths can recover without operation, and Case 40, in my opinion, proves this, though an operation was eventually performed. Under the influence of congestion hyperæmia, it either never came to suppuration, or whatever pus was already present was transformed into serum, similarly to Cases 27 and 38, and to Case 48, which will be reported hereafter. In all cases we succeeded in killing the producers of infection; for the serous contents were found to be sterile.

Acute Osteomyelitis.

Long ago I treated incipient acute osteomyelitis with congestion hyperæmia—for the first time in 1893. I have reported the first case several times. I cite it here once more:

46. A child was acutely attacked by high fever. After some time an inflammation of the knee appeared, which was soon followed by an effusion. The lower end of the femur was thickened and painful. The high fever disappeared, but a moderate temperature and the inflammation in the knee remained; and the latter did not improve, though the joint was treated antiphlogistically, was aspirated and washed out. The joint very soon became stiff and sensitive. I instituted congestion hyperæmia, which appeared in its most intense form. With one stroke the disease improved. In a few days fever, effusion, and inflammation disappeared, and the joint became mobile.

I have treated successfully several such cases. Certainly, I cannot produce the strict proof that we had actually to deal with osteomyelitis, as I did not demonstrate producers of infection or pus in the bone-marrow. But one needs to study the following case carefully. There is scarcely any other disease in children besides osteomyelitis which after a chill is followed by such intense febrile subcutaneous

inflammation of the extremities and sensitiveness of the bone. Formerly we always found in such cases, on early opening by operation, the suspected pus in the bone-marrow—nay, almost always already under the periosteum.

47. A boy, thirteen years, was attacked, October 28, 1904, after a fall, by chills, intense pains, and violent inflammation of the left lower leg. The boy was admitted October 30. The left leg was intensely swollen (the difference in measurement was 4 centimetres, and the boy was lean and pale at that), red, and extremely painful. The upper part of the tibia was very sensitive even to slight pressure. Conge tion hyperæmia was instituted, and it removed in twenty-four hours all subjective symptoms, and after four days all objective changes, including the rise of temperature. The boy got up November 4, and walked about without any trouble. Chart XI. shows the course of the temperature.

Two similar cases have been described by Burn-Murdoch.[1] Cases of osteomyelitis which from the very beginning run a mild course, and do not lead to breaking through of pus, show this prompt retrogression under congestion hyperæmia,

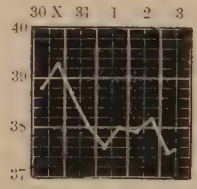

Chart XI.

even when they have existed for some time. Case 29, already described, offers a good example of this.

Of late I have not restricted myself to incipient cases, but have treated also the grave cases of osteomyelitis with large abscesses, suppuration of joints, and separation of the epiphysis, with congestion hyperæmia.

I proceeded in the following manner: As soon as pus was demonstrated, the abscess was either punctured with a thick trocar and irrigated with physiological saline solution, or opened by one or several incisions. The incisions were made small, so as not to expose the bone too much, because I was afraid to thereby favour necrosis. Pus was thoroughly pressed out and irrigated with physiological saline solution. Neither drainage nor tamponade was practised, again because I feared to thereby dry out the

[1] Burn-Murdoch, Edinburgh Medico-Chirurgical Society (*The Lancet*, 1907, January 26, p. 230).

bones and to favour necrosis, but simply covered the wound with a thick absorbent dressing.

In several cases of acute osteomyelitis I endeavoured at first to make use of mere puncture and irrigation of the abscess cavity. The following case belongs to this category :

48. A girl, twelve years, became ill suddenly in the night of January 5 to 6, with intense pains in the left thigh.

The child was admitted January 15. The entire left thigh was intensely swollen, especially at the lower half. At the outside and in the popliteal space was intense redness, œdema, and fluctuation. The knee-joint was intensely swollen, and it measured at diverse places 5·5 to 10 centimetres more than at the corresponding parts of the healthy side.

A congestion bandage was at once applied, which enabled the child to sleep quietly for the first time since the disease began. The abscess was opened January 16, with the patient in ether, by a thick trocar inserted from the outer side ; 100 c.c. of thick blood-tinged pus was evacuated, which contained a pure culture of staphylococci. The cavity was irrigated, and the place of puncture closed by a stitch. Two hours after the slight operation the congestion bandage was reapplied, and worn twenty-two hours daily. From the following day the patient had

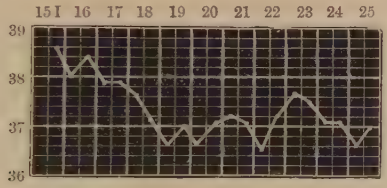

Chart XII.

no more trouble, and felt perfectly well. The duration of congestion hyperæmia was gradually diminished. The temperature, which had sunk to normal, rose again January 23. The vicinity of the place of puncture was reddened, and the upper part of the popliteal space tensely filled. I suspected reaccumulation of pus, opened under ether the cavity from the outside with an incision 8 centimetres long, but removed only about 100 c.c. of clear lemon-yellow serum. With the finger I felt the inferior surface of the femur to be denuded of periosteum from the lower epiphysis to its middle. The wound was sutured with silver wire, and the hæmorrhage arrested by a compressing dressing applied for one hour ; then a loose dressing was applied, and congestion hyperæmia again applied twenty-two hours daily. Temperature sank rapidly, the wound healed *per primam intentionem*, and the tense effusion in the popliteal space disappeared in a few days. The course of the temperature is illustrated in Chart XII.

The child remained in the hospital for observation until February 22. On discharge, all that reminded one of the past disease was considerable thickening of the femur and the scar of the operation.

I remark here, too, that mere puncture of the abscess is by no means to be looked upon as a rule for the treatment of suppurative osteomyelitis. Here, too, we have to deal

with attempts to remove the disease in the most sparing manner. Experience has shown that this suffices only in very rare instances.

I have therefore adhered to the rule to always incise osteomyelitic abscesses.

It will be found in some clinical histories that I have loosely sutured with silver wire incised osteomyelitic abscesses which I have treated with congestion hyperæmia. These are pure experiments, which have not yet been completed. I have mentioned these facts in order to suppress nothing in the clinical histories.

I cite a few cases of healed osteomyelitis with complications (suppurative arthritis, separation of epiphysis) :

49. A child, eight weeks old, was brought, February 10, 1904, to the Bonn polyclinic, with swelling and reddening of the left arm above the

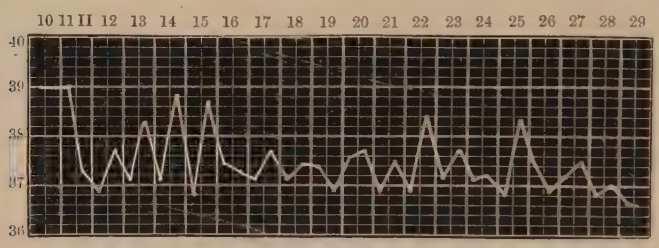

Chart XIII.

elbow-joint. The swelling fluctuated. The elbow-joint was held stiff in almost extended position, and was passively movable only to a very slight extent. The humerus felt thick Temperature was 39° C. The abscess was opened, and led to bone denuded of periosteum. The child was at once admitted to the hospital. After a sinking of the temperature it rose again, and the local condition became worse. The elbow-joint suppurated.

On February 16 the status was as follows : The left arm was considerably swollen and reddened from the upper third. The lower two-thirds felt greatly thickened. On the outer side of the upper arm was a granulating wound 3 centimetres long, in the depth of which the bone was exposed. The elbow-joint was very much swollen. Pressure on or motions with it expelled thick pus through the incision. The joint was approximately extended, and could be flexed only to a very slight degree. Redness and swelling extended above the arm over the left side of the chest and shoulder. Congestion hyperæmia, which appeared in its intense form, was applied twelve hours daily by the application of a rubber constrictor as high on the arm as possible. February 17 a separation of the lower epiphysis of the humerus was established. The first day's suppuration was extraordinarily profuse. In spite of the separation of the epiphysis, the elbow-joint was moved daily, and by this and the aid of pressure pus was evacuated from it. February 24 suppuration had almost completely ceased.

The congestion bandage was not worn February 24 to 28, and from then to March 3 only one hour daily. On that day the disease could be regarded as cured. The operation wound had a firm scab, the epiphysis had grown on, and motions of the elbow-joint were almost completely free. The small patient moved the joint himself. Soft crepitation in the joint, thickening of the lower two-thirds of the upper arm, and the operation scar, were the only traces left by the disease. The child was discharged March 19.

Chart XIII. shows the course of the temperature.

50. A child, nine years old, became ill a week before admission, with a violent inflammation of the right lower leg and the neighbouring knee-joint.

The child became seriously ill December 22, 1903, and was admitted with fever. The right lower leg was very much inflamed. At the upper end of the tibia plainly was an abscess, which was opened by an incision 6 centimetres long. This led to bone widely denuded of periosteum. With considerable swelling, suppuration of the knee-joint occurred as a complication. Diagnostic aspiration of the knee-joint, made December 29, showed pus containing staphylococci. Congestion hyperæmia was now instituted, which rapidly removed all phenomena of the knee-joint. January 9, 1904, an abscess on the outer side of the lower leg had to be opened by an incision 3 centimetres long. January 10 a bone sequestrum was expelled from the wound over the tibia. The congestion bandage was discontinued from January 31, as all phenomena of fever and inflammation had ceased. The pus effusion of the knee-joint disappeared, and the mobility of the joint was re-established. However, two sinuses remained at the tibia. These were explored March 2 with the patient under an anæsthetic One led superficially under the periosteum of the bone, the other into a small granulation cavity at the head of the tibia, and from there into the knee-joint. On curetting, some loose cartilage shreds and granulations were removed Motion of the joint caused the flow of clear synovial fluid. The lower part of the wound was sutured, the upper only covered with gauze. For the sake of safety congestion hyperæmia was again instituted. April 25 the operation wound was completely cicatrized. The child was discharged May 20. There was no effusion in the knee-joint, which was actively and passively movable to the fullest extent. There still existed swelling of the capsule and fairly pronounced lateral mobility. For this reason the child was given a hinge apparatus, which prevented the lateral motions.

In the fourth edition I reported over 22 cases of acute osteomyelitis which I have treated with congestion hyperæmia. Of these—

Healed without necrosis	10 cases.
,, with necrosis	11 cases.
Died of pyæmia	1 case.

I have to add, as regards the cases described in the fourth edition "still under treatment": In the case numbered in that edition as 51, resection of the suppurating knee-joint, because of caries, became necessary. In the case numbered as 52, as a result of removal of a sequestrum of the epiphysis of the tibia, the knee-joint became anky-

losed. In the case described under No. 53, we also had necrosis of the talus. A sequestrum of the size of a hazel-nut was removed from the talus. Contrary to expectation, the suppurating tibio-tarsal joint healed with approximately full function.

Since then we have treated four additional cases of acute osteomyelitis, the termination of which can already be stated. One patient was cured without necrosis, whose knee-joint was suppurating. The joint retained its full mobility. Three patients got well, with necrosis. To this must be added the above-mentioned necrosis of the talus, which was not recognized at first. The total result now is as follows :

Of 26 fresh acute osteomyelitis terminated by—

Cure without necrosis	11 cases.
,, with necrosis	14 cases.
Death from pyæmia	1 case.

The fatal case, which had nothing whatever to do with congestion hyperæmia, will be described in detail in a subsequent chapter.

In this enumeration, two cases of recurrent osteomyelitis have not yet been mentioned. They will be considered in the subsequent group.

I have observed the following peculiar case of acute osteomyelitis of the humerus, with suppuration of the shoulder-joint. It merits mention because of its importance.

51. A farm-labourer, aged twenty-eight, was admitted with a grave feverish osteomyelitis of the upper arm, and inflammation—probably suppurative—of the shoulder-joint. We succeeded in causing retrogression of the acute inflammation, and in completely curing the shoulder-joint without operative intervention; but there developed an enormous thickening of the bone. The Röntgen picture shows by the granulation and thickening of the bone that the entire diaphysis of the humerus is diseased, and a large sequestrum which has been included in the healing.

The case is of importance in so far as it shows that we have succeeded in causing a sequestrum to heal over. Whether or not we shall be compelled to remove it later on, time will show.

On the whole, the results achieved seem to me to be satisfactory. However, osteomyelitis does not establish the great usefulness of congestion hyperæmia with that positive

certainty as does the phlegmon of tendon sheaths. For our former methods of treatment for the latter on which we relied led, with insignificant exceptions, to death of the tendon; by congestion hyperæmia, however, we were able to cure more than half of the tendons, which had been bathed in pus for several days, and all of which perished with our former treatment. Acute osteomyelitis has not infrequently been observed by us to get well after simple incision of the abscess, without necrosis. On the whole, I am not altogether satisfied with my results of congestion hyperæmia in acute osteomyelitis. Certainly I do not go as far as Lindenstein,[1] who asserts that he has had only bad experience with congestion hyperæmia in acute osteomyelitis.

Evidently in acute osteomyelitis the bacterial toxins early lead to necrosis, so that the congestion hyperæmia can lead with some regularity to a perfect and rapid cure only when applied very soon after the occurrence of the disease. The difficult conditions for drainage of the pus from the depth of the bone may contribute their share. This seems to me the only possible explanation for the less successful results, when compared with staphylomycosis of the other tissues. Nordmann's[2] view, that the congestion hyperæmia does not extend to the bone-marrow, is not at all correct, as I have fully explained in the general part. Other experiences point to the great disposition of the bone to necrosis. Very often it dies in compound fractures, when the fractured ends, denuded of periosteum, are free in the wound, even when the wound is not infected.

At any rate, our past treatment of osteomyelitis with congestion hyperæmia is in need of reform; first, because of the deficient results; then again, because our remedy is often unable, as in other acute infections, to rapidly cause the disappearance of the phenomena of disease, high fever frequently remaining for weeks. Recently I have begun to make the following experiment: I incised—as used to be in vogue with the so-called "early operation," now justly neglected—extensively, chiselled open the bone, thoroughly removed the pus, closed the wound of the soft tissues by

[1] *Loc. cit.*

[2] Nordmann, "Erfahrungen über Stauungshyperämie bei akuten Entzündungen" (*Med. Klinik*, 1906, No. 29).

several silver wire sutures, leaving open wide spaces for drainage, and then instituted congestion hyperæmia. I make the suture of the wound loose, to prevent uncovering of the bone to a great extent. I feared this would lead to still further necrosis; that is to say, I had such harmful results with the "early operation," which I formerly very often performed, with wide-open wound and tamponade, that I soon abandoned it, except in grave septic cases. Similar attempts with extensive incision and subsequent suture have yielded favourable results from the inception of my treatment with congestion hyperæmia. I have only mentioned them in this book, because the experiments have been allowed to lapse, and they are therefore not concluded.

On the whole, other physicians (who otherwise are convinced adherents of congestion hyperæmia) are not satisfied with the procedure in osteomyelitis, as Nordmann,[1] Croce,[2] Stich[2], Heller.[2] Croce, arguing from Ritter's experience, directly cautions against the treatment of grave osteomyelitis with the constricting bandage. On the other hand, a few—as, for instance, Bardenheuer[2]—report good results.

Nevertheless, I maintain that *very recent* cases of acute osteomyelitis, and such running a mild course, heal very well under congestion hyperæmia applied in the old manner.

We had the worst results in acute osteomyelitis of the tibia, while in other bones they were relatively good.

Joints suppurating from osteomyelitis usually became stiff or ankylosed if a focus of the bone involved the joint, but where such was not the case they healed with good function.

Recurrent Osteomyelitis.

I have treated cases of so-called recurrent osteomyelitis with congestion hyperæmia for some time. These are occasionally favourable, as they seldom have sequestra, but as a rule only abscess, or even only granulation cavities, with but little pus in the bones. Excepting abscess of the bone, I have treated only seven cases with positively demon-

[1] *Loc. cit.*

[2] Transactions of the Thirty-fifth Congress of the Deutsche Ges. f. Chir., pp. 220-266.

strated suppuration, one of which I treated several years ago in Greifswald, with the result that in five I had good, and in two unfavourable, results. I cite one case which retrogressed without pus :

52. A factory girl, twenty-two years old, who was operated on two years ago for acute osteomyelitis of the right thigh, became ill after a period of weeks with vague pains in the hip and thigh, fourteen days prior to admission with fever and violent pains in the region of the left knee-joint.

She was admitted February 6, 1904. At the right thigh was a scar, drawn in and adherent to the bone, 12 centimetres long, and a considerable effusion in the right knee-joint. It measured at diverse places 2 to $3\frac{1}{2}$ centimetres more than the healthy joint. It was painful, and could not be flexed to a right angle without pain. The lower third of the concerned femur felt thickened, and was sensitive to pressure. The soft parts in the popliteal space were inflamed and infiltrated.

I suspected that an abscess had already formed behind the bone, but aspiration with a hypodermic syringe in the region of the most intense inflammation yielded no pus; that of the knee-joint gave serous liquid without bacteria.

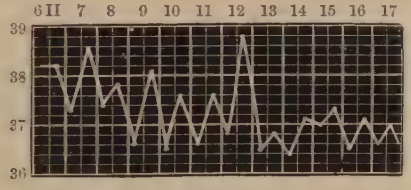

Chart XIV.

Congestion hyperæmia was applied twenty-two hours daily, and it appeared in the most intense form. In two days painfulness was relieved, and the joint was much more movable. From February 18 the congestion bandage was worn only twelve hours daily. February 26 the effusion of the knee-joint had disappeared. All phenomena of disease disappeared, the joint normally movable, and the patient left her bed. She was discharged March 16 as fully capable of doing her work. A slight thickening of the lower end of the femur was the only thing abnormal that could be demonstrated. The leg was usable to the fullest extent.

The accompanying Chart XIV. shows the course of temperature.

The following case represents an example of recurrent osteomyelitis, where, in spite of applied congestion hyperæmia, an abscess appeared, and where removal of the pus by aspiration produced a cure :

53. A stoker, aged twenty-two, had in 1891 an acute osteomyelitis of the lower part of the right thigh, in which the abscess was incised by the physician. There remained some sinuses which did not close in spite of the expulsion of two sequestra. Necrotomy was successfully performed in the clinic at Bonn in 1897. The patient was again received February 3, 1904, with new trouble at the old place.

The lower half of the right femur was considerably thickened, and sensitive to pressure. There were different operative scars, one 25 centimetres long, due to the necrotomy, which was painful at its lower part. Bodily temperature was slightly elevated. The right knee-joint was normally shaped and movable. Congestion hyperæmia was instituted for one hour daily. The disease did not improve, the temperature slowly rose from February 18, and the operation scar became red and more painful. February 22, in ether intoxication, two tablespoonfuls of fairly thick bloody pus was evacuated by puncture with a thick trocar from the outer side. The instrument struck rough bone. The abscess cavity was irrigated with physiological saline solution. The congestion bandage was again applied February 22 to March 10 twenty hours daily, and then discontinued. On that day the disease was considered cured. There were no more difficulties, and the patient rose March 14.

The course of the temperature, so far as it interests us, is shown in Chart XV.

Perhaps the one-hour congestion hyperæmia applied daily in the beginning did not suffice in this case, and it might have been possible to prevent suppuration by longer periods

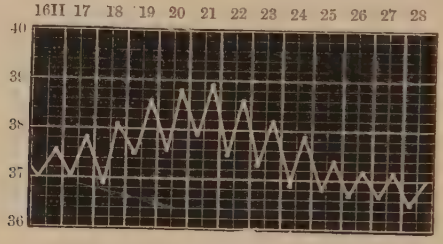

Chart XV.

of congestion hyperæmia. We intentionally experimented in this case with briefly applied congestion hyperæmia :

54. A secretary, aged eighteen, was ill two years ago with acute osteomyelitis of the right upper arm, for which reason necrotomy had been performed at the Bonn clinic. A year later he was operated on again for a recrudescence.

He was admitted June 11, 1904, with a new relapse. At the outer side of the right upper arm, above and below, were scars, each 10 centimetres long, and adherent to the bone. In the middle of the lower was a sinus opening of the size of a pea, profusely discharging pus. The upper arm was inflamed and swollen, and very sensitive to pressure. The inflammation extended to the elbow-joint, which was swollen, very painful, and fixed at a right angle. Temperature was but slightly elevated. Congestion hyperæmia was instituted. June 25 the sinus was closed. The patient was discharged July 11. All inflammatory phenomena had disappeared, and the elbow-joint, which could be extended almost to the full extent, was freely movable and useful.

A case where we had an unfavourable result will be described as No. 71.

The not infrequent cases of recurrent osteomyelitis of a grave septic form, in which the bones are filled with thousands and thousands of small abscesses, merit special discussion. We have treated only two such cases, both without result. One is the same as will be described under No. 71. In another case, which had in addition suppuration of the knee-joint and a suppurative infarct of the lung, after the useless application of congestion hyperæmia, amputation of the thigh had to be performed. The patient recovered. This case was one of streptococcus infection.

In regular *abscess of the bone*, which frequently also represents a recurrence of acute osteomyelitis, I have, as was to be anticipated, accomplished nothing with congestion hyperæmia. But recently we had a failure with such a case, which we regarded at first as an ordinary recurrent osteomyelitis, but which, on operation, proved a complete suppurative degeneration of the marrow.

Treatment of other Forms of Acute Inflammation and Suppuration of the Extremities.

I have treated with the congestion bandage, in addition to the enumerated grave forms of infection—suppurating large joints, phlegmon of the tendon sheaths, and acute osteomyelitis—all sorts of inflammation and suppuration ; *e.g.*, all kinds of panaritium, freshly infected wounds, carbuncle and furuncle, lymphangitis, acute itching eczema, etc.

Sick[1] saw a case of anthrax cured by the congestion bandage, and Küster[1] by a suction apparatus. This experience is in accord with the experimental investigations of Nötzel and v. Baumgarten, described in the General Section of this book.

The congestion hyperæmia is also suitable for non-bacterial inflammation, as, for instance, painful mosquito-stings, and for acute gout. This is reasonable from our standpoint ; for if we conceive inflammation as a useful reaction for the removal of the injury, it is immaterial whether the injury producing the inflammation is a bacterial toxin, or the

[1] Transactions of the Thirty-fifth Congress of the Deutsche Ges. f. Chirurgie.

acid of the mosquito-sting, or the uric acid of the gouty individual.[1] In every case where inflammation appears it is to be aided, not combated.

The effusion of blood into the tissues belongs here; for it, too, produces an intense inflammatory hyperæmia and inflammatory œdema, which in my opinion serve to dissolve the effusion. I have frequently applied congestion hyperæmia—it seems to me with success—in larger hæmorrhages into the tissues, in order to absorb the blood more rapidly. To be sure, I have at the same time applied hot air and massage, to produce rapid reabsorption; for this, as has been discussed in the General Part, is retarded while the bandage is applied. As a rule, however. I remove effusions of blood with hot air, because, as I shall show later, reabsorption is of more importance than solution.

As regards all the above diseases I can be brief; for the technique offers nothing special, it being the same as described in the preceding chapters. It must be added that cupping-glasses often are more practical than the congestion bandage in furuncles, carbuncles, and freshly infected wounds. This treatment will be described in a special chapter.

Treatment of Erysipelas.

I already reported in 1901[2] that I have treated erysipelas of the extremities, and especially of the face, with congestion hyperæmia. I saw in Greifswald, in the then old, hygienically defective hospital, an endemic of erysipelas of the face, which successively attacked a whole series of men. Thirteen of these cases (among which one recurred three times in the same patient) were treated by a congestion bandage around the neck. In only one case the erysipelas spread to the bandage. In all others it remained strikingly restricted. The average duration of the disease was four to nine days, the shortest one day, the longest nine days.

[1] Years ago I have reported that I have had no success with congestion hyperæmia in *an acute attack of gout;* but since then I have become convinced in several cases that the remedy is very useful for the gouty attack. Of late, several physicians have reported success with the congestion bandage in attacks of gout.

[2] Transactions of the Nineteenth Kongress f. Innere Med., 1901.

On the other hand, in two patients of the same endemic the duration of the disease (erysipelas of the head) was six days for one treated with alcohol dressing, eleven days for the other, treated only with aseptic dressing, the average being eight and a half days.

In the cases treated with congestion hyperæmia, the improvement of the general condition, the rapid decrease of temperature, and the rapid and profuse desquamation, were striking.

Nevertheless, this series of observations is too small to prove the favourable influence of the congestion hyperæmia in erysipelas, though it makes it probable; for erysipelas is an unreliable disease, and it may have been that accidentally a number of mild cases have been submitted to treatment.

Since that time I have seen erysipelas but rarely, streptomycosis in Bonn being strikingly rare; perhaps one appearing to every hundred of staphylomycosis, if I exclude erysipelas and suppuration of the middle ear. The few cases of erysipelas treated later have also not enabled me to form a positive opinion. Habs,[1] one of the most experienced and successful physicians in the domain of treatment with hyperæmia, had unfavourable results. On the other hand, Hochhaus[2] believes that his seven cases of erysipelas of the face which he had treated with congestion hyperæmia have been favourably influenced by it, and Sick[1] says that in some cases of erysipelas this treatment has rendered him excellent service.

Heller[1] makes the following noteworthy observation: While an erysipelas migrans spread under the bandage without recognizable influence, three cases of gangrenous erysipelas stopped in front of it. The cases terminated so favourably that he counts them among his best successes.

Payr[3] justly points to the fact that Wölfler and Niehaus, the former with a surrounding adhesive plaster strip, the latter with a ring of collodion, "restricted" erysipelas, but in reality, perhaps unconsciously, acting by "a technically im-

[1] Transactions of the Thirty-fifth Congress of the Deutsche Gesellschaft f. Chirurgie.

[2] Hochhaus, "Über die Behandl. akuter Halsaffektionen mittels Stauungshyperämie" (*Therapie der Gegenwart*, October, 1905).

[3] Payr, "Wölfler's Erysipelbehandlung. Eine historische Bemerkung zu A. Bier's neuer Verwendung der Stauungshyperämie" (*Wiener Med. Wochenschrift*, 1905, No. 38).

perfect and often insufficiently applied congestion hyperæmia."

Meanwhile the decision of the question has been rendered more difficult by the repeated observation that congestion hyperæmia applied for acute inflammation was followed by erysipelas. I will return to this in a subsequent chapter on the dangers of congestion hyperæmia.

PROPHYLACTIC TREATMENT OF RECENT WOUNDS SUSPECTED OF INFECTION, WITH HYPERÆMIZING AGENTS

I HAVE reported in the second edition of this book that we had begun to treat prophylactically recent wounds, suspected of infection, with congestion hyperæmia. Our experience was then limited to compound fractures and other suspicious wounds. Those on the extremities were treated with the congestion bandage, those on the trunk with suction apparatus. I then remarked that it was difficult to form an opinion about the usefulness of the procedure, for cases running a favourable course do not prove that it would have been otherwise without hyperæmizing treatment. The question also cannot be decided theoretically; for it cannot be said that the same remedy which cures or favourably influences a developed disease will necessarily prevent its establishment. But, according to observations made meanwhile by us[1] and numerous other physicians,[2] it seems to me that we succeed with a great degree of certainty in protecting suspicious and dirty wounds against infection. We have come to this conviction from the fact that recent wounds which did not show the conditions for a first intention healing, because they had been contused and soiled—for which reason we formerly should not have dared to close them—were sutured and healed by first intention. As an example, I cite the following case :

[1] Compare Joseph, "Über d. frühzeitige u. prophylakt. Wirkung der Stauungshyperämie auf infizierte Wunden" (*Münch. Med. Wochenschrift*, 1906, No. 38).

[2] Compare Transactions of the Thirty-fifth Congress of the Deutsche Ges. f. Chir. Nordmann, *loc. cit.* Hoffa, "Die Beh. v. Unfallschäden," etc. (*Münch. Med. Wochenschrift*, 1906, No. 44).

55. A labourer, aged thirty-one, intended to push forward a waggon loaded with tin plates by grasping the spokes of the wheel. Suddenly the waggon went forward, squeezing the hand against the tin plates.

The injured man went at once to the clinic. The dorsum of the hand, which was saturated with dirt, was torn to shreds, as if by a cog-wheel. Altogether there were four wounds running parallel, divided by small bridges of skin partially torn, partially incised. The wounds were very dirty, the metacarpal bones partially splintered; the capitulum of the third was so intensely crushed that the pieces had to be extracted. The extensor tendons of the second, third, and fourth fingers were severed.

The wound was cleansed as much as possible of all visible dirt, and irrigated with a solution of bichloride of mercury. The torn ends of the extensor tendons were sutured with catgut, and the cutaneous wounds closed as well as it was possible by numerous stitches. Two small places had to be left open, because so much skin had been torn off that the margins could not be approximated.

A compress was applied for two hours, then replaced by a loose dressing, and congestion hyperæmia instituted, which appeared intensely, so that the dressing became saturated with serous liquid, requiring repeated changing.

The sutures were removed February 17. The wounds, except at the two open places, had healed by first intention. The tendons had grown together very well.

I only remark that the patient was given a prophylactic injection of tetanus antitoxin. We do this in all seriously contused and dirty wounds.

This procedure has frequently rendered us good service in similar cases, especially in serious compound fractures. Above all, we have not hesitated to close the wounds after operations by loosely applied sutures at infected bodily parts. We afterwards produced with congestion hyperæmia a sort of first intention, which shortened the course of healing and produced better function of the diseased parts. The contribution of Joseph from the Bonn clinic offers in support of this a number of examples. Prophylactic hyperæmia, therefore, is destined to play a great rôle in surgery. It makes surgery still more conservative by diminishing the consequences of industrial accidents by prevention of infection, avoidance of major surgical procedures, and by the possibility to early apply sutures. It was a satisfaction to me to hear from the president of a great industrial society that the results of physicians who make use of congestion hyperæmia in this manner was noticeably useful to the treasury of the society and to the labourers.

Habs[1] reports that prophylactic congestion hyperæmia has shown itself without any influence on the development of syphilis. A physician injured himself during an operation

[1] Transactions of the Thirty-fifth Congress of the Deutsche Ges. f. Chir., i., p. 221.

on a syphilitic for inflamed phimosis. Habs immediately applied prolonged congestion hyperæmia. In spite of this, a chancre developed at the place of injury, followed by grave general syphilis, though suppuration was prevented.

I am indebted to Habs for another interesting observation, reported to me privately: In spite of prophylactic congestion hyperæmia, a grave injury of the leg was followed by tetanus. I had a similar experience with recent cases of tetanus in Greifswald, where tetanus was not at all infrequent. As soon as the first symptoms appeared, congestion hyperæmia was instituted, with tetanus antitoxin administration. The results were always bad. I also applied congestion hyperæmia of the head, in order to affect the toxic central nervous system, but also with no success whatever.

I have for this reason adhered to my old custom of administering tetanus antitoxin, in spite of prolonged congestion hyperæmia, in all wounds suspected of infection.

In connection with this experience are experiments which I have undertaken with a view to changing the aseptic treatment of wounds. It would be incredibly foolish for a surgeon to question its brilliant accomplishments. But in spite of asepsis we have not yet progressed so far that we can guarantee with certainty the healing by first intention of *all* wounds adapted for suture. How often, for example, does it occur that silk threads are expelled, or that a wound which, on the whole, has healed by first intention shows small defects (stitch abscesses, sinuses)! It is easy to try to play the anticipator, so to speak, and to place the wound in a state of inflammation by one of the numerous irritants at our disposal, which mostly are also antiseptics, and to thus nip infection in the bud.

It must be added that healing of the wound, in a certain sense, is an inflammatory process. It therefore does not seem advisable to remove from the wound every stimulus. In this respect our experiments have yielded a uniform result. I was able to demonstrate throughout that the scars became firm more rapidly and strongly than in wounds treated aseptically without irritation.

The procedure, however, has not proved of value in the former respect. I have applied it in about 500 larger

wounds, which approximately had the conditions for a first intention, but I could find no advantage over the purely aseptic treatment. I have tried all sorts of irritants, of course, greatly attenuated. The favourite iodine proved the most useful. But even with its application I saw that not infrequently mild late suppuration made its appearance. The wound appeared healed by first intention after the usual time; then an abscess developed slowly and with slight phenomena of inflammation, from which not infrequently silk threads were expelled. Cupping-glasses always produced rapid healing of this suppuration.

TREATMENT OF ACUTE INFLAMMATION AND SUPPURATION OF THE HEAD WITH A CONGESTION BANDAGE PLACED AROUND THE NECK[1]

Congestion hyperæmia of the head is, as a rule, applied eighteen to twenty-two hours daily. Here, too, now and then, exceptions are made, and each case must be individualized. If, for instance, pronounced œdema takes place, or if the bandage at first inconveniences the patients, longer intermissions are ordered. Generally speaking, the bandage is correctly applied when the face appears somewhat swollen and bloated. A fiery red œdema occurs here, too, at places having an inflammation; but while on the extremities the redness extends to the constrictor, it is restricted in the head to the inflamed places and their immediate vicinity. Only when there exists contemporaneously extensive acute inflammation of the glands of the neck widespread phenomena of inflammation appear.

Generally a certain œdematous swelling in congestion hyperæmia of the head should rapidly reach the margin of the constrictor, but there are variable degrees in the intensity

[1] Those interested in the pressure relations of the brain, altered by congestion hyperæmia, will find them fully described and graphically presented in Bier, "Über d. Einfluss künstl. erzeugter Hyperämie d. Gehirns und künstl. erhöhten Hirndrucks auf Epilepsie, Chorea u. gewisse Formen v. Kopfschmerzen" (*Mitteil. a. d. Grenzgebieten*, vol. vii., Nos. 2 and 3, 1900).

of the œdema. Cases in which the soft parts of the neck hang over the bandage in the form of œdematous bags alternate with those in which the bloating of the face is the only sign of serous infiltration. While, again, in the extremities a good deal of time is required to remove, by elevation, the œdema produced by the congestion bandage, this occurs much more rapidly in the head, the circulatory condition being excellent. A few hours after removal of the bandage the patients have their usual appearance.

The periods of application of the congestion hyperæmia are shortened correspondingly to the degree of improvement of the disease, but this should not be undertaken too early, as otherwise a return easily occurs.

On first glance it may appear to be an adventurous proposition to produce intense congestion hyperæmia of the head by a bandage placed around the neck, and to allow it to remain twenty to twenty-two hours at the same place. A change of the place of application at the neck is not easy, because the bandage must always be applied below the larynx; for above it it cannot be successfully applied, and over it it produces inconvenient pressure phenomena. But one need only remember that, because of the rich vascular supply of the head, congestion hyperæmia is here produced much more easily than at the extremities. For this reason there is no need to make several turns of the bandage around the neck, the simple woollen-rubber bandage, described in the General Part, lined with a layer of flannel, sufficing. If in a delicate skin the appearance of pressure phenomena is threatened, hardening of the skin by washing with alcohol or spirits of camphor is indicated. Occasionally we have observed insignificant excoriations, which we dusted with zinc oxide and covered with cotton, and continued with the application. The rubber bandage can be replaced by a flannel bandage, firmly applied around the neck in several turns. It is impractical, however, because it is felt by the patient to give rise to a disagreeable warmth, and because it takes up more room than the narrow rubber band—a circumstance of importance when, in addition to the main disease, there is present secondary glandular swelling, necessitating application low down in the neck.

In the head, too, the most striking effect of congestion hyperæmia is the relief of whatever pain may be present. It has proved itself of value as a sedative and hypnotic. We have, furthermore, repeatedly observed that heads kept stiff in a forced position, owing to inflammation, became mobile after twenty-four hours.

The constrictor, of course, is at first not at all agreeable. It produces a sensation of oppression at the neck. But the patients soon get used to it. But the bandage must never produce real inconvenience, and must be loosened when the patients complain of pressure and heaviness in the head. The novice should first undertake congestion hyperæmia of the head in adults, so as to be able to judge from their statements. After he has learned the method on them, and knows how to interpret the objective changes, he can apply it to children.

In suppuration of the head, the congestion bandage acts in the same way as on the extremities. This will be discussed with the individual cases. I can here only say in general, that everything we have described for the extremities holds good also for the head, except to a greater degree. The inflammatory swellings appear doubly large, and return to normal, in spite of continued application of the bandage, as soon as the disease becomes better or healed. Similar conditions hold good also with regard to suppuration. We have seldom seen a transformation of an acute hot abscess into a chronic one and disappear, and we found that small incisions proved sufficient for its removal.

I mention here also that the size of the incision has no prominent, practical significance as regards our principle.

The significance of the entire omission of incision rather pertains to theory. It is, practically, of greater importance to avoid drainage and tamponade even in abscesses of the head. Pus is to be removed simply by pressure and irrigation. In a series of cases we have successfully applied suction with the cupping-glass, as is soon to be described.

I made diverse use of head congestion already years ago. As regards acute inflammatory diseases, I have treated only acute cerebro-spinal meningitis and erysipelas with it. For over three years I have systematically applied

it in all cases of inflammation and suppuration of the head, face, and upper part of the neck, in the Bonn clinic and Johannis hospital.[1] I describe the method in detail for the important

Acute Suppuration of the Middle Ear, and its Complications.[2]

We have treated all cases of suppuration of the ear with congestion hyperæmia, irrespective of whether they came in the acute or chronic stage, with or without complications. Naturally the surgeon sees the latter more frequently. We saw only one case of middle-ear inflammation which had no complications. But just the complicated disease of the temporal bone, according to our experience with similar pathologic processes in the extremities, offers a suitable field for our treatment. We have seen cures of acute and chronic osteomyelitis by congestion hyperæmia, and could therefore anticipate cure of suppuration of the temporal bone, as the smaller bone surface and the lessened disposition to formation of sequestra, together with the excellent blood-supply, enabling the easy production of effective hyperæmia, promise good success.

As regards the special treatment of suppuration of the middle ear, I mention the following : If the patient comes to us with a perforation of the tympanum, which allows free drainage, we omit any further procedure. If the opening is insufficient, it is dilated or a new one is made. If there has not been a perforation, we perform paracentesis as soon as a suspicious prominence or discoloration of the tympanum causes us to surmise the retention of pus. And what has been said for the accumulation of pus in the drum membrane holds good also for abscesses of the mastoid process. When there is a suspicion of suppuration it should be incised. Whenever we have proceeded differently from this plan in cases treated with congestion hyperæmia, we have simply sacrificed it to the study of the method. Though we have

[1] Compare Keppler, "Die Beh. entzündlicher Erkrankungen v. Kopf u. Gesicht mit Stauungshyperämie" (*Münch. Med. Wochenschrift*, 1905, Nos. 45, 46, 47).

[2] All cases treated have been also watched by Eschweiler, and have been submitted to careful observation by a specialist.

generally had no unfavourable experience, it never occurred to us to make this expectant position our practical principle. As yet we also do not care to formulate final rules for the size of the incision. As a general proposition we recommend the performance of small incisions, though large ones cannot be avoided when we have to deal with deeply situated suppurating glandular metastases.

I will now explain the details of our treatment in connection with the clinical histories of a few of the most suitable cases. I believe it best to limit myself to the selection of the following acute cases, for the treatment employed in them is the very one indicated in the chronic forms of mastoiditis.

56. A girl, aged ten, became affected four weeks ago with violent pain in the left ear, which somewhat diminished two days later after the appearance of a sero-purulent discharge from the ear; but as suppuration from the ear remained unchanged in its intensity, and as in addition the patient began to complain the last few days of pain in the neighbouring bone of the skull, the patient was admitted to the hospital February 18, 1905. The head is held bent towards the left side, and can be changed from that position only with pain. The upper wall of the auditory canal has a diffuse swelling and depression. The tympanum is intensely swelled and reddened, and shows in the lower half a point-like perforation, through which exudes profusely a muco-purulent liquid. The soft parts over the mastoid process are œdematous, and reddened over a large area, but fluctuation cannot be demonstrated with certainty.

Pressure over the inflamed parts elicits intense pain. Temperature in the axilla 37·9° C.

Treatment was limited to the application of congestion hyperæmia for twenty-two hours. After two days the sensitiveness to pressure over the mastoid process is almost gone, without the inflamed appearance having changed essentially. The swelling has rather become more pronounced under the congestion hyperæmia. Fluctuation, however, cannot even now be demonstrated with *positive* certainty. The auditory canal was daily freed from its pus by sponging, and closed by a piece of sterile gauze.

Daily continued congestion hyperæmia shows, February 25, almost complete disappearance of the pain. Redness and swelling over the mastoid process have retrogressed, so that the process appears covered by normal skin. The profuse suppuration from the ear has diminished considerably. Temperature returned to normal during the last few days.

Suppuration ceased completely March 4, and as the mastoid process, too, does not show any morbid phenomena, congestion hyperæmia was discontinued on this day.

The patient was discharged cured March 8. The tympanum has become pale, so that the handle of the malleus was again plainly visible. The situation of the perforation can no longer be found. The ability to hear is undisturbed.

57. A labourer, aged thirty-one, became afflicted five weeks ago with intense pains in the left ear, which were accompanied by decided rise of temperature. The inflammatory phenomena disappeared when, a few days later, discharge of a large quantity of thin pus from the ear made its appearance. The patient was admitted May 15, 1904, because the profuse

discharge has not diminished, and because for the past fourteen days this was complicated by boring pains in the neighbouring mastoid process. The region of the left ear is so swollen that even at a distance a pronounced asymmetry of the head can be noticed. The left ear protrudes considerably from the head. The region behind it has a very large œdematous swelling and is fiery red. The redness is very painful to pressure. Fluctuation, however, cannot be demonstrated with certainty. The left external auditory canal is filled with thick, foul pus. After its removal by sponging appears a pronounced swelling and depression of the upper wall.

The tympanum is reddened and swollen throughout its entire extent, and shows a large perforation in its lower half. Hearing on the left side is nil. Temperature, measured in the axilla, is 37·6° C. The treatment in this case, too, is restricted to congestion hyperæmia applied twelve hours. A striking result is the rapid decrease of the pain. A few days after the institution of treatment sensitiveness to pressure over the mastoid process has fully disappeared, though the objective changes were not favourably influenced by the remedy. On the contrary, inflammation has rather increased, so that its termination in suppuration can hardly be doubted. We intended to allow the obvious abscess to perforate by itself, but it retrogressed under continued congestion hyperæmia. On May 25 the swelling and redness have completely disappeared, and the mastoid process is again covered by normal soft parts. The discharge from the ear has become greatly diminished in quantity, the tympanum has lost its swelling; the perforation, however, is still visible in its lower half, through which from time to time pus still exudes. This, too, ceased very soon, and the patient was discharged June 13 with everything in normal condition. Tympanum is normal, the perforation cannot be found any more, hearing is undisturbed.

This condition was verified by an additional examination in December, 1904.

The above illustrate two cases of acute mastoiditis which we have been able to cure with congestion hyperæmia exclusively, without even an incision. Whether early incision would have enabled us to reach the goal sooner remains very doubtful; nevertheless, we would here, too, establish the rule of early incision of whatever abscesses may be present.

I now report three other cases of acute mastoiditis in which the congestion hyperæmia has been supported by incisions made at the same time.

58. A young man, aged eighteen, of pale and suffering appearance, is admitted July 25, 1904. He states that he has suffered for a number of weeks from discharge from the left ear, and for the past fourteen days there has also appeared painfulness and swelling over the mastoid process. The left auditory canal discharges a considerable quantity of grey, foul pus. The region behind the left ear is intensely swollen and reddened over an area as large as the palm of the hand. It shows throughout its extent fluctuation, and is extremely painful, not only on pressure, but also spontaneously. Examination shows the tympanum reddened and swollen in its lower posterior quadrant; on the summit of a wart-like projection a round perforation was visible. Whispered words can be heard 1 metre away. Temperature in the axilla is 38·6° C.

Under Schleich's local anæsthesia the swelling behind the ear is immediately attacked by an incision 4 centimetres long, which evacuates a quantity of ill-smelling pus. After expression of the latter, it can be seen that not only the mastoid process, but also the squamous portion of the temporal bone, is denuded of periosteum. A sinus of the bone cannot be discovered. The wound is not tamponaded, but loosely covered with an aseptic protective dressing. Two hours later congestion hyperæmia is instituted, which is maintained twenty-two hours. In this case an extraordinary swelling of the entire face was produced. For example, the region of the eyes was so intensely swollen that œdema almost completely covered the palpebral fissure. Correspondingly we also observed in this case rapid improvement. The sero-purulent secretion, which came profusely from the operation wound the first few days, diminished soon afterwards, and ceased altogether August 1 Even pressure scarcely produced any secretion from the wound. Mastoid process and squamous portion of the temporal bone are fairly free from sensitiveness to pressure. In the same manner a decrease of the discharge from the ear was observed. The improvement proceeds so rapidly that the patient was able to be discharged completely cured as early as August 17. The wound of the operation is perfectly cicatrized. Suppuration from the ear has ceased since a week, and the seat of the small perforation cannot be found any more. Words spoken in a whisper can be heard 6 metres. In this case congestion hyperæmia was maintained until the day of discharge.

This report was confirmed in every respect by another examination made in December, 1904.

After having drawn attention to the course and influence of this method in ordinary mastoiditis, I should like to report two cases of so-called Bezold's disease. As is well known, this is a form of mastoiditis which is characterized by a burrowing towards the incisura mastoidea. The danger of this disease becomes evident from the anatomic relations. Owing to the depth of the place of perforation, towards the middle of a thick muscle layer, in immediate proximity of the loose layer of connective tissue of the neck, the pus will seldom find its way outward, but there is the danger that it will burrow between the deep muscles of the neck, and especially alongside the sheaths of the large blood-vessels. Such complications, of course, must be combated as early as possible. We shall indicate how the conditions are modified under the application of congestion hyperæmia.

59. A boy, aged eight, admitted to the clinic August 4, 1904. According to the statement of the parents, he suffered for weeks from a discharge from the left ear. In the last days a swelling has appeared on the same side of the neck. Thin foul pus is profusely discharged from the left auditory canal. The walls of the canal appear reddened and swollen. In the hind lower quadrant of the intensely reddened tympanum a small point-like perforation is seen. The entire mastoid process is extremely sensitive to pressure, though its coverings do not show any pronounced phenomena of inflammation, except a certain œdematous swelling. Only at the apex of the process are the soft parts somewhat reddened and extra-

ordinarily sensitive to pressure. This place, altered by inflammation, terminates below in a hard infiltration of the size of a chicken's egg, which is covered by reddened skin, in the depth of which fluctuation can be plainly recognized. Temperature in the axilla is 38·2° C.

In addition to a daily cleansing of the external auditory canal, the treatment up to August 6 is limited to twenty-two hours' congestion hyperæmia. In spite of this treatment of only two days, the discharge from the ear has become plainly diminished. The bad odour has disappeared almost completely. The original sensitiveness to pressure over the mastoid process cannot be demonstrated any more. The temperature has returned nearly to normal, though the abscess has remained unaltered; but as the fluctuation has become more pronounced, the abscess is opened August 6 by an incision 4 centimetres long. From the depth of the anterior margin of the sterno-cleido-mastoid a large quantity of thick pus is evacuated, in which staphylococci are demonstrated both with the microscope and by culture. The incision is loosely covered by a protective dressing. Tamponade is not employed, in spite of the depth of the abscess. Two hours after the operation congestion hyperæmia of twenty-two hours' duration is again instituted.

In the first two days after the operation considerable pus is discharged from the wound, but subsequently rapid cessation of the suppuration is observed. August 20 the wound is cicatrized, and the infiltration of the soft parts has completely retrogressed. Suppuration of the ear had ceased already some time ago, and examination with the speculum shows no morbid changes. Patient is sent home healthy.

60. A young man, aged seventeen, is said to have first noticed a discharge from his right ear three weeks ago. Fourteen days later, with accompanying phenomena of fever, a swelling appeared behind the ear, which gradually increased in its circumference. For this reason the patient entered the clinic February 2, 1904. The right ear is forced away from the head, the soft parts of the mastoid process show marked reddening and swelling, and terminate below in a dense infiltration about 12 and 11 centimetres wide, extremely sensitive to pressure. The swelling is covered throughout its entire extent by reddened skin, and shows deep fluctuation. A profuse quantity of sero-purulent liquid is discharged from the right auditory canal. Examination with the speculum shows a rather large vertical perforation of the intensely reddened tympanum.

An incision 12 centimetres long in the direction of the sterno-cleido-mastoideus muscle is made over the swelling. On deep dissection a large quantity of thick pus is evacuated, in which microscope and culture show the presence of streptococci. We reach a wound cavity larger than a chicken's egg extending behind under the sterno-cleido, and forward up to the middle of the neck. The pus cavity is carefully sponged out, but a quantity of necrotic tissue shreds is let alone. Compression controls the hæmorrhage, and the wound is loosely drawn together by three silver-wire sutures, and covered with an aseptic protective bandage. Two hours later congestion hyperæmia of the neck is instituted for fifteen hours. The suppuration, which was rather profuse during the first few days after the operation, has greatly diminished after one week's treatment. The thick creamy pus has been gradually replaced by a thin serous secretion, which exudes, on compression of the wound margins, in moderate quantity. The mastoid process is now covered by normal soft parts, and is not sensitive to pressure. The original swelling at the side of the neck scarcely shows an inflammatory appearance. Redness and swelling, which had increased considerably in the first days of congestion hyperæmia, have now almost entirely retrogressed, though the bandage had meanwhile not been removed. The suppuration from the ear is noticeably diminishing. Redness and swelling of the walls of the auditory canal, which have prevented

inspection during the first days of congestion hyperæmia, have become insignificant, so that the central part of the canal and the tympanum have again become visible. The latter is partially covered by epithelial scales, and the perforation can still be recognized, through which, on prolonged observation, a discharge of some secretion can be seen. The continued application of congestion hyperæmia enables us to discharge the patient cured March 9. Examination with the speculum shows everything normal. On the right side of the neck a solid scar is seen about 10 centimetres long, and of strikingly blue colour.

Examination by a specialist made in December, 1904, shows in the lower half of the tympanum a small scar; there is no secretion; hearing undisturbed.

Recently we have rapidly cured a third case of Bezold's mastoiditis by means of congestion hyperæmia.

The only case of acute inflammation of the middle ear with participation of the mastoid process which we have treated with congestion hyperæmia without success is that of a lady thirty-seven years old, to whom I was called in consultation by Dr. Brockhoff:

61. Six years ago the left antrum was drilled through the alveolar process for suppuration, and the left sphenoidal sinus and ethmoid cells were opened after resection of the middle turbinate. The suppuration still exists, for which reason antrum and sphenoidal sinus are daily syringed.

In October, 1905, the lady began to suffer on both sides from acute inflammation of the middle ear, subsequent to an attack of influenza. October 19 the condition was as follows: On both sides the posterior upper quadrant of the tympanum bulged out in the shape of a nipple. At the apex of each prominence was a perforation, from which pus exuded. The tympani were evenly reddened. Both mastoid processes were sensitive to pressure; their periosteum, however, was not swollen.

The discharge became so profuse during the next few days that the auditory canals had to be sponged every two to three hours (also during night). The mastoid processes remained sensitive to pressure. The patient complained of cutting pains in the depths of the ears. November 5 appeared a torturing urticaria, which spread all over the body, and which remained fourteen days. November 19 a slight depression of the upper auditory wall was noticed.

Congestion hyperæmia was applied from November 20 to December 6, in the first few days twenty-two, then ten to twelve hours daily. Hyperæmia and swelling occurred in the desired form. The discharge thereupon became thinner, but did not diminish in quantity. As the sensitiveness to pressure did not improve, and as the posterior upper wall of the auditory canal sank so low that the latter became narrowed to a slit, the congestion hyperæmia was discontinued December 6, and operation performed December 11.

On the right side, after elevation of the periosteum, pus was profusely discharged from the angle between external and posterior walls of the auditory canal. The mastoid process was necrotic, of about the size of a five-pfennig piece (1½ centimetres in diameter), but not yet cast off. After chiselling off of the cortex, which was very hard, the entire mastoid process proved to be destroyed and surrounded by a pus and granulation focus extending to the apex.

The cellular structure extended very high and far into the wall of the

auditory canal. The cells were honeycombed by granulations. The wall of the sinus was thickened to 2½ centimetres length and 1 centimetre width by granulation layers, and therefore had been surrounded to that extent by pus. In the external section of the posterior wall of the auditory canal was a hole.

On the left side conditions were similar, only the cavity in the mastoid process was larger than on the right side. Here, too, the cellular structure extended very high.

The diseased bone was thoroughly removed on both sides. Healing of the wound was good. In eight weeks the operation wounds became cicatrized. Convalescence was disturbed by a hæmorrhagic nephritis.

Whoever has frequently had to chisel the mastoid processes knows how variable are the pathologic processes which he is apt to meet with, and operation will show but in a limited number of the cases the condition which was expected from the pre-operative condition. Even the most experienced meet very often with an error in diagnosis. For example, the operator observes all the signs pointing to abscess of the mastoid process, only to discover no trace of pus after operation. Again, bone fistulæ, or even extensive sequestra, are met with in cases only a few weeks old, in which, with the exception of an insignificant swelling of the soft parts, no sign whatever pointed to such a progressed destruction. This difficulty in diagnosis prohibits us from utilizing the external appearances as conclusive evidence regarding the pathologico-anatomic conditions in the interior. We should from operation gain nothing more than conjectures, especially in our cases, since in the majority of them our small incisions enabled us to inspect but a very small part of bone surface.

As inspection of the bones enabled us to form an opinion, as is mentioned in the concerned clinical histories, in the rest of cases the findings on examination with the speculum enable us sufficiently to form a decided opinion. At any rate, whoever carefully investigates the more exact clinical histories recently published by Keppler[1] will be able to see clearly in regard to our cases this which will principally impress him, that all classes, from the mild to the gravest, are represented in our material.

We cannot end this discussion without at least briefly referring to the small incisions which we make for the evacuation of pus; this is all the more imperative since similar small incisions had been made some time ago for

[1] Keppler, "Die Behandlung eitriger Ohrerkrankungen mit Stauungshyperämie" (*Zeitschr. f. Ohrenheilkunde*, vol. l., No. 3, 1905).

therapeutic purposes, the so-called "Wilde's incision," and which for a long time have enjoyed great popularity. The reputation of these simple incisions, however, has long ago been proved to be exaggerated. For this reason most operators have abandoned this small procedure, and when it is now occasionally recommended, it certainly has been in cases the character of which was by no means positively established. Körner, in his well-known book on suppurative diseases of the temporal bone, expresses his doubt as to the ability of Wilde's incision to produce a cure of acute suppuration of the bone: at least, he believes it to be effective only in mastoiditis in small children. But in those there was not necessarily a suppuration of the bone itself, for in the majority of cases we have to deal with empyema of the antrum, which burrows through the yet open mastoid-squamous fissure, thus simulating disease of the bone. Here Wilde's incision merely imitates the spontaneous burrowing through the skin, and can, like it, lead to a cure.

But where cures from the incision in adults have been reported, Körner thinks the proof is wanting that there really was suppuration of the bone. He, at best, admits an exudate in the healthy bone cells, capable of resorption, but does not except the possibility of diagnostic errors (subcutaneous abscesses, periostitis, suppurative lymph-glands in furuncles of the auditory canal). It is necessary to mention that other authors, too, have observed healing of pronounced formation of abscess in the mastoid process after Wilde's incision; but these are rare exceptions which, according to Politzer, mean nothing more than that occasionally, under certain circumstances, suppurative processes of the mastoid process can heal without operative measures; but to him they do not establish the curative effect of the incision. To this must be added that our small incisions should not be compared with Wilde's incision, for the latter is more extensive, and is alleged to heal by the withdrawal of blood, a condition not fulfilled in our simple "stab" incisions. We have made our incisions merely to deal with extension of the suppuration, and believe that it can only have the same significance ascribed to similar procedures for abscesses of the extremities.

If our contentions in regard to the importance of the

incisions can be established, the decisive effect of hyperæmia appears very probable to them, and is indeed proven by those cases of unquestioned mastoiditis in which a cure was effected without any other procedure save that of hyperæmia.

Our observations of suppurative disease of the middle ear are based until now on twenty-eight cases, seventeen of which came to us in the acute stage; the rest had already passed into the chronic stage. Now, a differentiation between acute and chronic suppuration of the ear is arbitrary, and a sharp line cannot be drawn, for the one passes into the other. We have counted all cases which have existed two months, and which did not show pronounced phenomena of inflammation, as chronic; all those of shorter duration, and highly inflamed ones, among the acute forms.

With one exception all cases, acute as well as chronic, have been complicated by the mastoid process being involved.

Though we reasoned from the very beginning that these complications would not offer unfavourable conditions for a cure, our theoretical considerations were supported by the results achieved by us.

Participation or non-participation of the mastoid process has in no instance been indicative of the termination. This was rather influenced by the stage in which the patient had reached us at the time of admittance. Of the seventeen cases of *acute mastoiditis* which we have observed, sixteen have healed in the very favourable average period of three weeks, and that, save one exception, with good hearing. In the exceptional case, the attending aurist (Eschweiler) asserted that he could positively confirm our opinion that the diminution of hearing-power (the patient could hear whispered language at a distance of 4 metres) was due to an old trouble in the labyrinth.

All these cases, except Case 61, had been referred to us for the operation of chiselling open the mastoid. This is natural, for the physician sends patients with ear disease to a surgical clinic for no other purpose. They also showed the indications usually calling for that operation.

Of the chronic cases, two recovered by congestion hyperæmia without incision, with full auditory function. One of these was a case of recurrent mastoiditis after a previous chiselling

operation, the other a chronic suppuration of the middle ear with the formation of a polypus (this was the only case not complicated by mastoiditis). The polypus at first shrank to half of its circumference under congestion hyperæmia, then remained uninfluenced, and was removed with the snare. Both cases, therefore, prove nothing, because the first one would have probably recovered without congestion hyperæmia by mere rest, and the other perhaps after removal of the polypus.

Of the remaining nine cases, we had in one large sequestra, as the disease was eleven months old, and had developed after an attack of scarlet fever ; in three others we observed cholesteatomata. It requires no special explanation to show how these four cases could not have recovered without operation. Hyperæmia was applied because the correct diagnosis could not be made at first. We concluded that the above-mentioned complications were present from the lack of results from congestion hyperæmia.

There remain five cases, in two of which the chronic mastoiditis healed and remained quiescent, as shown by repeated examinations by a specialist ; suppuration of the middle ear, however, remained. Undoubtedly the children (and the cases are those of children) were taken away too early, before the conclusion of the treatment, and we did not succeed in getting them to re-enter the clinic. It is, however, very probable that we should have succeeded in curing these cases, which now are uncomplicated, by renewed treatment (congestion hyperæmia, irrigation, good hygienic conditions). It is to be regretted that we have not had any more cases from which to gain a correct opinion on these things.

In this purpose two additional cases may possibly be utilized ; in one, however, for other reasons, a prolonged experiment with hyperæmia treatment could not be made, while in the other the anamnesis led to an early operation. The boy had had some weeks previously an attack of scarlet fever, which made the presence of a sequestrum probable. We call attention here to the peculiar state found at the operation : the bone after prolonged application of congestion hyperæmia appeared extraordinarily rich in blood, and in a few cases, especially in cholesteatomata, a strikingly sharp line of demarcation of the diseased

parts could be observed. Above all, we have been led to conclude that the duration of after-treatment has been considerably reduced by a previous hyperæmization.

The last case of chronic mastoiditis, which was complicated by an abscess of the brain, died. Its course was as follows :

62. A stonebreaker, twenty years, suffered since childhood from a right-sided suppuration of the ear, which occurred periodically, and which gave not the least trouble for years, save some difficulty in hearing. The patient became ill February 6, 1906, rather suddenly, with fever and severe pain in the right ear and intense headache, which disappeared in the next few days with improvement of the general condition. February 11 in the morning the condition took a turn for the worse, with exhaustion and vomiting, which occurred twice, and the patient came to the clinic in the

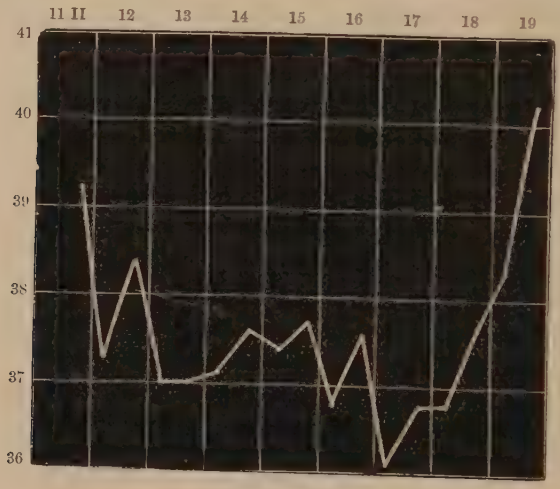

Chart XVI.

evening. On admission he complained of nausea and headache, which he could not definitely localize.

February 12 the patient's status was as follows : Pale-looking man ; the right ear profusely discharged grey, fœtid pus. The mastoid process concerned was sensitive to pressure, but showed no other phenomena of inflammation.

On examination with the speculum, the entire external auditory canal was reddened and swollen ; the tympanum, which was visible only to a small extent, was also very much inflamed.

The possibility of abscess of the brain was considered, because of the nausea and headache ; but as all other symptoms of brain abscess were wanting, the probable diagnosis of an old cholesteatoma was made. Congestion hyperæmia for twenty-two hours was instituted daily.

This reduced the temperature. The patient was the following day free from complaint, and remained out of bed all day. The local condition and the fœtid discharge remained unchanged.

This favourable condition kept up until the morning of February 17. The patient had approximately normal temperature, and walked about throughout the day; but on the morning of the 17th the condition became strikingly worse. The patient looked miserable, could not think well, and complained of intense headache, not exactly localized. Temperature normal, pulse 63.

Though we had no symptoms of abscess of the brain, operation was proceeded with a few hours after the appearance of the phenomena described.

The mastoid process was much sclerosed, and without hollow space; the middle ear was filled with suppurative granulations. The sinus was unchanged. After opening of the middle cranial fossa, a large abscess was evacuated from the temporal lobe of the brain; 20 c.c. of fœtid green pus was removed. The abscess was opened freely, and a drainage-tube inserted. Patient died February 19 with high temperature.

Necropsy showed an abscess cavity of the size of a walnut, thoroughly opened and empty, in the temporal lobe, but otherwise no pathologic changes. The course of the temperature is shown in Chart XVI.

I do not believe that in this case the diagnosis of brain abscess could have been made sooner, and that the operation was performed in time. During the period of observation up to operation the pulse did not fall below sixty.

Nothing else pointed to brain abscess except the headache and one attack of vomiting. To this must be added that the congestion hyperæmia, which had been maintained five days up to operation, at once removed all trouble, the patient feeling well, being up and about.

I do not understand how Isemer can assert that this case is a sad example of how congestion hyperæmia may mask grave complications, and that the patient probably could have been saved by an operation performed a few days earlier.

I believe it unnecessary to offer a detailed description of the remaining chronic cases, as the technique of the treatment differs in no wise from that described with the acute cases. Anyone specially interested in the diseases under consideration is referred to the quoted contributions of my assistant, Dr. Keppler, whose statements I have followed.

Taken all in all, the results obtained in chronic cases are not very encouraging, and we do not know whether we can yet advise experiments in this respect. We ourselves, of course, will try to enrich our experience in this direction. We are forced to this by the favourable results experienced in chronic osteomyelitis of the extremities. These results compel us to look upon certain cases of chronic mastoiditis as suitable for treatment with congestion hyperæmia. This

applies to cases which have no sequestra, but in which abscess or, better still, granulation cavities are found in the interior of the bone.

It is natural that, in view of our brilliant results, we should warmly recommend the congestion hyperæmia treatment for cases of acute mastoiditis. Anyone who will in such cases proceed according to the rules laid down by us will obtain results which will bear comparison with those so far achieved by operation. Again, our main interest in our procedure is the excellent function which we have brought about as a part of the cure in all cases of acute ear trouble. This is undoubtedly the greatest advantage over operative treatment, which not infrequently affects the functions of the ear.

We cannot judge whether congestion hyperæmia will produce the same results in uncomplicated suppuration of the ear, as all our cases, with the exception of a chronic one, have been complicated by mastoiditis.

I have not included the new cases of mastoiditis which have been observed during the last year in the two hospitals under my control, because they have not been observed and treated by us, but by Eschweiler independently, who himself will report on them. I will report only one fatal case in a future chapter devoted to the failures.

Among aural physicians, except Eschweiler, who has co-operated with us in the observation and treatment of our cases, Heine and Stenger are the only two who have contributed literature on the treatment of suppuration of the ear and its complications by hyperæmia since the appearance of the preceding edition. Heine[1] succeeded in curing nine out of nineteen cases.

In two the mastoiditis was cured; suppuration of the ear, however, remained; eight have been operated. These cases have run a more unfavourable course than ours. I believe Heine would have had better results if he had awaited the exact report of our cases treated for the past three years. He has been led to operation by phenomena which we have not regarded as an indication. He operated on one case of

[1] Heine, "Über d. Beh. d. akuten eitrigen Mittelohrentzündung mittels Stauungshyperämie nach Bier." Address delivered at the Congress of the Deutsche Ges. f. Otiatrie, 1905; and *Berliner Klin. Wochenschrift*, 1905, No. 28.

Bezold's mastoiditis as early as after two days, because at first he believed it to be too risky to treat this form of mastoiditis with congestion hyperæmia. He furthermore operated when no improvement was seen a short time after institution of the treatment. But we have experienced in one of our cases that the acute suppuration of the ear and mastoiditis, which had remained four to five weeks without special improvement by our method, was in time completely cured.

Stenger[1] was the second to publish his observations.

These are of interest in so far as he has treated the cases of suppuration of the ear complicated by mastoiditis with suction apparatus. He opened the subperiosteal abscess by an incision 2 to 3 centimetres long, and elevated the periosteum up to the external auditory canal. If a sinus was found, he enlarged it with the sharp spoon ; if none was found, he made a hole with a fine chisel into the mastoid antrum, or into a cell communicating with it. In this bone opening he inserted loosely a strip of gauze and applied a cupping-glass, which became filled with blood, pus, and serum. The cupping-glass is removed after three hours if it has not become filled before. Stenger achieved good and rapid results in seven cases with this method.

It may be objected to Stenger's treatment that it does not represent a less procedure than when the entire mastoid process is removed as in the old manner. But I believe that Stenger's procedure has a greater justification if performed under local instead of general anæsthesia. Earlier, when I used to do ear operations very frequently, I became convinced that the opening of the mastoid process with the chisel—nay, even curettage of the middle ear—can be fairly well performed under Schleich's infiltration anæsthesia, but the periosteum must be thoroughly infiltrated.

Of late Haslauer,[2] Fleischmann,[3] and Isemer,[4] have, on the whole, expressed themselves in a derogatory manner about their experiences with congestion hyperæmia in suppuration

[1] Stenger, "Die Bier'sche Stauung. bei akuten Ohreiterungen" (*Deutsche Med. Wochenschrift*, 1906, No. 6).

[2] Haslauer, "Die Stauungshyperämie bei der Beh. v. Ohreiterungen" (*Münch. Med. Wochenschrift*, 1906, No. 34).

[3] Fleischmann, "Über d. Beh. eitriger Mittelohrerkrank. mit Bier'scher Stauungshyperämie" (*Monatsschr. f. Ohrenheilkunde*, 1906, No. 5).

[4] Isemer, "Klin. Erfahrungen mit der Stauungshyperämie nach Bier bei d. Beh. d. Otitis media" (*Archiv f. Ohrenheilkunde*, vol. lxix.).

of the ear. In this respect I refer to Eschweiler's contribution, soon to appear.

The subject Congestion Hyperæmia in Diseases of the Ear has been damned with a certain passion at the last Otologic Congress[1] in Vienna. With a plainness not to be misunderstood, there and elsewhere it has been said that the successes so far attained have been made by "non-experts."

On reading these and other outcries of otologists, I have at least had the unalloyed joy of having made a good prognosis. When we treated our cases, I have repeatedly said to my assistant, Keppler, who was to prepare this material: "You should never alone record the status, never make diagnoses or establish indications independently; and, furthermore, do not alone control the results by examinations. Eschweiler is to control everything. I am convinced that the otologists will tell us: 'What does such an ordinary surgeon know of ears? He has taken an eczema of the auricle or a furuncle of the external auditory canal for a mastoiditis.'"

This prediction has been entirely justified, in spite of Eschweiler's co-operation. Alexander went the farthest at the Vienna assembly. Brief, impudent, and conceited, he declares: "It seems to me that it" (he means congestion hyperæmia) "is applied by people who understand nothing of the matter." I can quietly endure for myself the "non-expert" and ignoramus. I have become used to worse; for my whole doctrine of hyperæmia in surgery was at first looked upon by "authorities" and experts as a sort of humbug, because they then, as now the otologists, had "throughout negative results." But against my colleague, the specialist Eschweiler, such a procedure is, to say the least, impolite.

I admit that congestion hyperæmia is not suitable for all cases of suppuration of the ear, and I do not intend to do away here or in surgery with operative treatment. But I maintain that congestion hyperæmia is an excellent remedy in most acute cases of this kind. I possess that much power of observation, though I am not a specially trained aurist. And if this be correct, congestion hyperæmia *must* be tested, even at the risk that it may produce here and there mischief. For the value of such remedies experience is gained by successes and failures, which themselves lead to an improvement in the establishment of diagnoses and indications. Should this not be possible here too?

That several aurists have been unable to confirm the anodyne effect of congestion hyperæmia looks to me suspicious for the technique employed, for we have always observed this except in two cases. Among surgeons who have tested this method, no one doubts that the remedy relieves the pain

[1] Transactions of the Deutsche otologische Ges., p. 26. Published by Gustav Fischer, Jena, 1906.

of inflammation. And the otologists have not an inflammation of their own ?

Finally, the treatment of inflammation of the middle ear with hyperæmia is still in need of very thorough investigation, especially on the part of unprejudiced aurists. Many questions have to be settled—Whether inflammations of variable etiology are equally influenced by congestion hyperæmia ? Whether the method is suitable for chronic cases ? a question we have been unable to decide because of the limited material at our disposal. Whether sinus thrombosis and brain abscess require special precaution, and whether treatment with the congestion bandage or with suction appliances is to be preferred ? We have limited ourselves to the former in order to gain first sufficient experience.

It cannot be sufficiently emphasized that even in the acute cases with a favourable prognosis careful technique and conscientious watching are essential.

The fact that all our acute cases complicated by mastoiditis save one were cured is due to the merit of my assistant, Dr. Keppler, who used congestion hyperæmia by the bandage with special skill and care.

Diseases of the Eye.

It is but a step in advance to apply congestion hyperæmia also to inflammatory diseases of the eye. I have only treated a real case of eye disease with congestion hyperæmia once. The case was placed at my disposal by the kindness of Privy Councillor Sämisch, with the diagnosis of far-progressed sympathetic ophthalmia, which had led to almost complete blindness of the second eye. It remained, as was to be expected, without any influence. I deemed it probable that we could achieve good results in such cases if the treatment be instituted sufficiently early. If, however, the views of several oculists—which will be referred to later on—that neither congestion hyperæmia of the neck nor the suction appliances are capable of producing an appreciable hyperæmia of the inner eye, even in inflammation, be correct, then these experiments are useless. As an example of acute dacryocystitis, which we have successfully treated with the procedure, I present the following two cases :

63. A child, three years old, was sent to the clinic July 12, 1904. It has fever (38° C.). The mother claims to have noticed about eight days ago a painful swelling of the right eye, which subsequently greatly increased in size. At the inner side of the right eye, corresponding to the situation of the lachrymal sac, an extremely painful swelling of the size of a hazel-nut is seen. It is covered by thin skin, intensely red from inflammation, and plainly shows fluctuation. Pressure produces pus from the punctum lachrymale. The skin of the cheek in the immediate vicinity of the sac is also reddened and œdematously swollen. The eye itself is in a condition of irritation. It shows tearing and injection of the conjunctival vessels. The cornea, however, is smooth and shiny. The pus sac is opened by a small incision, and freed from its contents by pressure. Two hours later congestion hyperæmia of the neck is instituted for twenty-two hours. This treatment rapidly produces improvement. After a few days the suppurative focus is "dried up." Redness and swelling have disappeared almost completely after a temporary increase, and pressure over the originally painful area of the lachrymal sac is not painful. July 18 the small wound has cicatrized, and, as there are no inflammatory phenomena, the bandage is dispensed with. A few days later the patient was discharged. At the place of the small incision a fine scar could only be discovered after a careful search, and other inconveniences, such as the production of tears, have ceased.

64. A man, sixty-six years old, says he has suffered for a number of years from too abundant tears. In the middle of April, 1905, intense pains suddenly appeared, and in the course of three hours a decided swelling developed at the inner side of the left eye. The patient suffered at the same time from disturbance of the general condition. His sensorium is not free, and he has vomited repeatedly. The temperature rose with chills to 39·7° C. The gravity of the disease forces him to ask aid of his family physician late in the evening. We find the patient in the condition just described. The region of the left lachrymal sac bulges forward, covered by red skin, and extremely sensitive to pressure. Fluctuation can be plainly demonstrated. The neighbouring skin of the eyelids and of the cheek is attacked by the same inflammatory process. The eyelids are so œdematously swollen that the eye is entirely covered. On pulling the lids apart, chemotic elevation of the conjunctiva bulbi et palpebr. is observed. In spite of the gravity of the phenomena, we thought it best at first to restrict ourselves to congestion hyperæmia of twenty-two hours' duration, which is begun for the first time at 10 p.m. The next morning the picture has changed considerably. Patient states that soon after the application of the bandage pus was discharged from the eye, after which the pain rapidly disappeared. He has passed the greater part of the night sleeping. In full accord with the subjective improvement, the objective phenomena, too, have become much better. Inflammatory redness and swelling have disappeared almost completely, and nothing is seen of the fluctuation which was so plainly demonstrable on the previous evening, though spontaneous perforation can be shown nowhere. Even forceful pressure on the lachrymal sac produces scarcely any pain. The eyelids have almost completely lost the swelling, so that the bulbi are again free. The temperature fell to 37·6° C.

We needed only to continue this treatment for two more days in order to discharge the patient completely cured. Of the disease there remained only the previously existing discharge of tears, for which we suggested dilatation of the lachrymo-nasal duct.

A number of oculists have recently experimented with the treatment of diseases of the eye by means of congestion

hyperæmia. Renner[1] believes he obtained considerable improvement in keratitis parenchymatosa; otherwise he has as yet been unable to pass a decided opinion on the value of the remedy in diseases of the eye.

Hoppe[2] reports a more extended experience. He found that with observation of the necessary precautions the diseased eye experiences no disadvantages from congestion hyperæmia of the head. He gives the sensible advice to avoid congestion hyperæmia in insignificant diseases of the eye, or such as are easily cured by simpler agents, but to try it without hesitation in graver affections rebellious to other forms of treatment. He had good results with the congestion bandage in a number of inflammatory diseases of the eye. and he especially noticed its pain-relieving effect, as observed in other bodily parts.

Hoppe's observation is noteworthy. Moderate congestion hyperæmia of the head extends to the investing membranes of the eyeball, and even the interior of the eye, though to a greatly reduced extent. Increase of the congestion hyperæmia of the head. on the other hand, does not increase orbital fulness, but somewhat diminishes it.

Wessely[3] made extensive experiments on animals with regard to the influence of congestion hyperæmia on the inner eye. He demonstrated that neither congestion by bandage nor suction glasses produce a decided hyperæmia.

I do not consider that Wessely's experiments present a positive proof. To demonstrate hyperæmia in the interior of the eye, he made use of the following method : He found that in hyperæmia of the inner vesse'ls of the eye, which he had produced by subcutaneous injections of saline solutions, these vessels allow albuminous bodies in larger quantity to pass in proportion to the intensity of the hyperæmia. If he produced the most intense degree of congestion hyperæmia of the eye, the osmosis of the inner vessels for albumin either did not increase at all, or very slightly. From this Wessely concludes that hyperæmia of the inner eye did not occur.

[1] Renner, "Über Bier'sche Stauungshyperämie bei Augenkrankheiten" (*Münch. Med. Wochenschrift*, 1906, No. 2).

[2] Hoppe, "Einwirkung d. Stauungshyperämie als sog. Kopfstauung (nach Bier) auf d. normale Auge und d. Verlauf gewisser Augenkrankheiten" (*Klin Monatsblätter f. Augenheilk.*, vol. xliv., 1906, p. 389).

[3] Transactions of the Berliner Med. Ges., December 5, 1906 (*Berliner Klin. Wochenschrift*, 1906, No. 51, p. 1634).

I consider it possible, but by no means positive, that this conclusion is correct. In my opinion subconjunctival injections can produce an *inflammation*, therefore more than a mere hyperæmia. There is, however, a great difference between the exudate of inflammation and the transudate of congestion hyperæmia.

Admitted that congestion hyperæmia really does not extend to the interior of the healthy eye, this, nevertheless, is no proof that it does not occur in the diseased, especially inflamed eye. For in other bodily parts, too—*e.g.*, the lower extremities of certain individuals—it is very difficult to produce a hyperæmia in a condition of health ; but when they have inflammation success is easily achieved even with very slight constriction.

Furthermore, Wessely's demonstration is of importance, that a threatening interocular pressure is not produced by the application of a congestion bandage around the neck.

The question of how far congestion hyperæmia can be made use of in ophthalmology,[1] and the effect of congestion hyperæmia on the interior of the eye, was discussed in detail at the congress of ophthalmologists held last year in Heidelberg, in connection with Wessely's address. Opinion varied greatly, so that a definite opinion is impossible.

It seems to me, however, that ophthalmology has long ago, though unconsciously, made use of hyperæmizing agents which are especially applicable to the eye.

I add that some time ago an oculist, Kauffmann,[2] has alternately made use of rarefying and condensing air, in order to apply a sort of massage. He made use for that purpose of a cupping-glass similar to the one suggested for hyperæmization of the eye.

Acute Cerebro-Spinal Meningitis.

As mentioned repeatedly, I have applied congestion hyperæmia of the head in a series of cases of cerebro-spinal meningitis of a tuberculous and suppurative form. The

[1] Report of the Thirty-third Convention of the Ophthalmol. Ges., published by Bergmann, Wiesbaden, 1907, p. 143.

[2] Kauffmann, "Über die Anwendung einer Luft- und Wassermassage am Auge" (*Wochenschrift f. Therapie u. Hygiene des Auges*, vol. v., No. 22).

only case in which the congestion bandage was followed by success is—

65. A boy, fifteen years old, was subjected to a radical operation for a cholesteatoma of the ear. The first two days passed without any event, but during the third night a striking turn for the worse of the general condition was noticed. Patient cries frequently during sleep, vomiting occurs repeatedly, and early in the morning the temperature has risen to 39·4° C., with a pulse of 140. The patient lies in a comatose state. If spoken to energetically, he complains of intense headache. The bulbi are incoordinate, the pupils are unequally dilated. The head is held stiff and backwards, and shows the presence of a pronounced hyperæsthesia. The tamponaded wound cavity shows no reaction. We at once institute congestion hyperæmia of twenty-two hours' duration. In accordance with our other observation, we saw here, too, rapid decrease of the pains, and hand in hand with this subjective improvement a rapid disappearance of the objective morbid phenomena was observed.

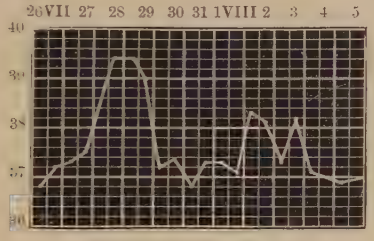

Chart XVII.

The temperature (compare Chart XVII.), which fell on the very first evening, sank to normal the next morning. Vomiting has ceased, the bulbi are again in coordination, the pupils are equally wide, and a hyperæsthesia of the skin cannot be demonstrated. The headache disappeared almost completely after one day's treatment. In the next few days an evening rise of temperature was observed twice, but we were unable to find a reason therefor. From August 4 the temperature was constantly normal, and no disturbance of the general condition appeared.

It is to be regretted that we neglected to practise lumbar puncture in this case. But the case was too characteristic, so that there could be no doubt whatever about the diagnosis.

Even in the cases running an unfavourable course, we noticed considerable improvement of the subjective condition.

The recent epidemic of cerebro-spinal meningitis offered an excellent opportunity to test the influence of congestion hyperæmia on this disease. I do not know whether anyone has tried the method.

It is possible that the favourable result following lumbar aspiration in acute meningitis is to a great extent due to the hyperæmia produced by it. For the removal of liquor

cerebro-spinalis naturally produces hyperæmia of the cerebral meninges, just as the removal of ascitic or pleuritic exudate produces hyperæmia of the peritoneum or pleura respectively.

It is therefore probable that congestion hyperæmia of the head and lumbar puncture could be combined with advantage.

Acute Parotitis.

I twice had the opportunity of treating cases of acute parotitis, which developed after abdominal operations, with congestion hyperæmia.

66. A young man, aged nineteen, was laparotomized July 5, 1905, for ileus, caused by extensive adhesions. Two days later patient complained of dragging pains in both sides of the face. The temperature rose in the evening to 39·4° C., and during the night developed the typical picture of acute double-sided parotitis. After the application of congestion hyperæmia of twenty-two hours' duration we are enabled to observe here, too, the rapid diminution of the extremely violent trouble. But as no recession of the inflammatory phenomena was observed in the next few days, we decided to incise in both sides, though fluctuation was not at all plain. A large quantity of pus was evacuated from both sides. Continued congestion hyperæmia produces a cure of both abscesses in fourteen days. All that can be seen on both sides is a small scar due to the incision.

A similar case has been described under No. 21. Because we hesitated about opening the abscesses, these burrowed into the external auditory canal. It is advisable in such cases to make a small incision early when there is the slightest suspicion of an abscess, for otherwise there is the danger of the abscess breaking through, not, as in Case 21, in front, but behind the tympanum, thus producing suppuration of the middle ear.

Acute Lymphadenitis.

In the following case we were at first in doubt as to whether we had not to deal with a case of parotitis. The course of the disease showed that it was a secondary infection of the lymph-glands.

67. A tinner, aged twenty-seven, suffers for the last two and a half years from suppuration of the accessory cavities of the nose, characterized by constant headache and discharge of pus through the nose. He has been operated on four times, the last time after Killian's method, without noticeable improvement of either objective or subjective phenomena.

After the second operation the patient was suddenly attacked by aphasia, with hemiplegia of the entire right half of the body. The patient

was paralyzed three months, and even to-day there still exists a pronounced weakness of the right half of the body, and from time to time disturbance of speech was noticed. The patient became afflicted in the last part of February, 1905, with a painful swelling in the region of the right ear, accompanied by fever, which necessitated his admission to the clinic March 4. A decided broadening of the right half of the face was striking. In front of the right ear there was a slightly elevated round swelling of a diameter of about 5 centimetres. It was covered by inflamed œdematous skin, and extremely sensitive to pressure. Fluctuation could be demonstrated with certainty. The swelling passes in the submental region into a diffuse swelling of the size of a fist, which, too, was covered by inflamed skin and is sensitive to pressure. Details cannot be obtained by palpation of the stone-hard infiltration. Examination of the ear shows normal conditions. Profuse thin pus mixed with blood is discharged from the nose.

Treatment consists of congestion hyperæmia of twenty-two hours' duration. We soon notice rapid improvement of the subjective phenomena, though the objective symptoms did not improve at once. The notes made March 14 show an apparent aggravation of the original condition; though the suppuration from the nose has improved, the inflammatory swellings have grown to almost double their original size. Now fluctuation can be plainly demonstrated. In spite of continuously maintained congestion hyperæmia, very soon a diminution of the inflammatory swelling could be observed. The diffuse board-like infiltration in the submental region was transformed into a sharply defined tumour, which can be easily recognized as a collection of swelled lymph-glands. Patient is discharged cured March 27. The suppuration from the nose has ceased, and the swelling, originally of the size of a fist, remained as a lymph-gland of the size of a dove's egg. An examination in July shows a very slight swelling in the parotid region as the only sign of a former disease.

Parulis.

We have treated with great success grave cases of parulis by means of the congestion bandage, for which I offer two examples:

68. A girl, twelve years old, suffered a week ago from an attack of toothache. A few days later a swelling appeared in the region of the right lower jaw, which rapidly increased in size, so that admission to the clinic became necessary, August 18, 1904. The swelling appeared with symptoms of fever. The soft parts of the right half of the lower jaw are swollen throughout, and very sensitive to pressure. The skin appears red from inflammation, and deep-seated fluctuation is demonstrable. The teeth are spasmodically pressed together, and can be but little separated. However, inspection of the mouth is accomplished by the aid of Heister's gag. The gums in the region of the right lower jaw are discoloured greyish-white. There is pronounced fœtor ex ore. The last premolar tooth and both molars of the right lower half of the jaw are loose. The premolar shows pronounced caries.

Temperature in the morning, taken in the axilla, is 38° C. Under ether the swelling (of the size of a chicken's egg) is opened through an incision 2 centimetres long along the margin of the lower maxillary. A large quantity of thick ill-smelling pus is evacuated, which microscopically and by culture shows staphylococci. The pus is squeezed out as much as possible, and the wound, without tamponade, is merely covered by a

protective bandage. The lower maxillary bone was denuded of periosteum to a great extent. Finally the diseased premolar is extracted. Two hours after the operation congestion hyperæmia at the neck is instituted. Congestion hyperæmia of twenty-two hours' duration produces in a few days complete drying of the large wound cavity. The wound is agglutinated August 21, and even pressure does not produce pus between its margins. The inflammatory redness and swelling after a temporary increase has almost totally receded, and is no longer sensitive to pressure. Temperature varies in normal limits. Patient is discharged cured as early as August 24. At the place of incision the wound is replaced by a fresh scar 1½ centimetres long, and the lower jaw-bone still feels thickened. Other signs of the former disease are not present.

69. A labourer, forty-one years old, suddenly began to suffer fourteen days ago from violent pains in the region of the left jaw, but he was unable to hold responsible any particular tooth. A few days after the appearance of the pains there also appeared a painful swelling of the left cheek and region of the lower maxillary, so that opening of the mouth became more difficult from day to day. As finally fever made its appearance, patient sought clinical aid July 24, 1904.

The left cheek and region of the lower jaw is intensely swollen and reddened. The swelling is extremely sensitive to pressure, and fluctuation can be plainly discerned. The left eye is covered by the œdematously swollen eyelids, separation of which shows that the conjunctiva of the bulbi is chemotically elevated. Teeth are pressed together spasmodically, and cannot be separated actively. Sufficient separation is impossible, even with the aid of Heister's instrument, for which reason the structures of the oral cavity cannot be inspected. Temperature in the axilla, taken in the evening, is 38·4° C.

With Schleich's infiltration anæsthesia the inflammatory swelling is opened by an incision about 5 centimetres long. A profuse quantity of pus is soon discharged, which microscopically and by culture shows the presence of staphylococci. The finger introduced into the wound enters upwards into a large abscess cavity, in which superior maxillary and neighbouring malar bone are denuded of periosteum to quite an extent. After squeezing out the pus the wound is merely covered with a sterile protective dressing. Finally the mouth is opened with Heister's gag. The last upper molar is carious and loose, and is therefore extracted. Two hours after operation congestion hyperæmia at the neck is applied for twenty-two hours.

After two days' treatment the patient's troubles have disappeared, and with the subjective well-being the objective phenomena rapidly receded. Temperature is normal, and the inflammatory redness has disappeared after a temporary increase. Most astonishing, however, is the extraordinary influence on the suppuration. In spite of the abscess cavity being larger than a hen's egg, the dressing is saturated by a moderate quantity of pus, and even pressure elicits but little secretion from the open wound.

Continued congestion hyperæmia of twenty-two hours produces cessation of suppuration July 4, and scarcely anything can be seen of the swelling of the face. The duration of congestion is shortened for this reason. Patient is discharged cured July 11. The operative wound has been closed for the last few days. In its place a thin scar 4 centimetres long can be seen. The left half of the face shows an insignificant swelling, and sensitiveness to pressure cannot be demonstrated.

We have treated with the congestion bandage numerous cases of acute periostitis or osteomyelitis of the jaws.

They terminated rapidly without exception if they came early under treatment, not one being followed by necrosis of the bone. This seems to me noteworthy, for in all cases concerned the patients were admitted to the hospital because of the gravity of the disease phenomena. In a series of milder cases we have treated in the dispensary we have made use of suction appliances, soon to be described. The good results in parulis are confirmed by Bardenheuer.[1]

Treatment of Diseases of the Mucous Membrane of the Mouth and the Upper Air-Passages.

Henle[2] recommends the treatment of acute coryza with congestion hyperæmia. He achieved a rapid and good result in five out of six cases. The one failure is explained by the chronic nature of the case and by the incomplete treatment.

I could confirm Henle's observation on my own person when I was attacked by a cold in the course of last winter, which I aborted by means of the congestion bandage in twenty-four hours; usually this affection lasts with me for weeks. Müller[3] reports a case of stubborn hay-fever which was very rapidly cured by congestion hyperæmia of the head. On the other hand, Hoppe[4] reports that he has seen no success with this remedy in a case of hay-fever which affected the nose and conjunctiva.

Hochhaus's[5] experiments in the treatment of diphtheria, with a bandage placed around the neck, appear to me of great importance. In thirty-six cases so treated he saw "that the results as compared with those obtained by the now usual diphtheria antitoxin were so much better that he can recommend the application of congestion hyperæmia, especially since no disadvantages have occurred." Hochhaus noticed that the deposits were more rapidly separated,

[1] Transactions of the Deutsche Ges. f. Chir., Thirty-fifth Congress, 1906, p. 235.

[2] Henle, "Zur Beh. d. akuten Schnupfens" (*Deutsche Med. Wochenschrift*, 1905, No. 6).

[3] Müller, "Über d. Anwendung d. Bier'schen Stauungshyperämie gegen Heuschnupfen" (*Therap. Monatshefte*, 1906, p. 444).

[4] Hoppe, "Einwirkung d. Stauungshyperämie als sog. Kopfstauung (nach Bier) auf d. normale Auge," etc. (*Klin. Monatsblätter f. Augenheilkunde*, vol. xliv., 1906).

[5] Hochhaus, "Über die Behandlung akuter Halsaffektionen mittels Stauungshyperämie" (*Therapie d. Gegenwart*, October, 1905).

that the diphtheria did not descend to the larynx, and that complications were rarer. It must be added that Hochhaus considered himself obliged to inject antitoxin in the graver cases. For this reason the experiments are not pure. Hochhaus's results were not so favourable in angina. He could demonstrate in the majority of instances only a subjective improvement. We ourselves have made the same observations some time ago, for which reason we have abandoned the procedure.

Prym[1] recommends for acute tonsillitis suction appliances on the same principle as we make use of in inflammatory affections of external parts. He constructed for that purpose special apparatus.

It may prove of advantage to throat specialists to resume the experiment made by me some years ago, of treating tuberculosis of the larynx by means of a congestion bandage applied below it. I had but once opportunity for this. The treatment did not last long enough to be of any value, and I have lost sight of the patient.

CAN CONGESTION HYPERÆMIA BECOME DANGEROUS IN ACUTE INFLAMMATION AND SUPPURATION ?—CONTRA-INDICATIONS

Anyone under the spell of antiphlogosis will involuntarily ask : Cannot the congestion hyperæmia become harmful in acute inflammation, which in itself frequently leads to grave circulatory disturbances ? Can it not even lead to gangrene of the attacked areas ? I must confess that I myself have had the same fear, and for this reason expressed myself in the first edition of this book, when the second time I wrote on the treatment with congestion hyperæmia of phlegmonous affections, as follows :

" But I emphatically state that it is not advisable for any physician to apply congestion hyperæmia in such cases, unless he has acquired a familiarity with the remedy in other affections, and that the remedy is suitable in such cases only when seen early. I am convinced that the greatest mischief can be produced with the remedy in progressed cases of phlegmon of the soft parts. The circulatory disturbance in such cases is so pronounced

[1] Prym, " Über d. Beh. d. entzündl. Erkrankungen d. Tonsillen mittels Saugapparaten " (*Münch. Med. Wochenschrift*, 1905, No. 48).

that gangrene of the attacked parts is threatening, in which cases the removal of the congestion is indicated, and not an increase of the latter."

I admit that there is such a variety of inflammation, but it is extremely rare, and it is not the circulatory disturbance, but the producer of inflammation (essentially bacterial toxins), which kill the tissues, as I have shown in the General Part. It is advisable, especially for such physicians as are little experienced in the method, to abstain from the application of congestion hyperæmia in inflammation with considerable congestion. At any rate, in such inflammation, whatever abscesses may be present should be thoroughly incised. To this, however, must be added that in all the cases of acute progressed suppuration which I have treated with congestion hyperæmia I have not seen a single case

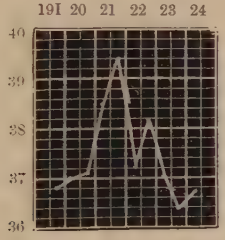

CHART XVIII.

where the agent produced real or lasting harm, and but one in which it was not tolerated on the extremities.

70. This case is that of a grave panaris of the periosteum and tendon sheath of the thumb, which had existed for three weeks, and which had been elsewhere treated by incision. The patient was a factory hand sixty-nine years old. The man was admitted in the Johannis Hospital April 28, 1904. The following day a new incision was made, and a sequestrum and necrotic tendons were removed from the basal part of the thumb. This operation was followed by a violent acute inflammation of a gangrenous character. For this congestion hyperæmia was instituted May 4 eight hours, May 5 and 6 ten hours. The pains of the patient increased under this treatment, and he desired the removal of the bandage. As also the inflammatory phenomena rather increased than decreased, his wish was granted. Exarticulation of the thumb with the metacarpus showed that there was nothing to be preserved on this member. In addition to the necrosis of the bone and tendons, the joints had become suppurative.

I have observed twice a transient disturbance in the treatment of suppuration with congestion hyperæmia, the cases

having been almost cured. Both cases showed almost the same course. I will describe one of them :

The man described under case 34, who has been treated with congestion hyperæmia for suppuration of the elbow-joint, suddenly was attacked January 21, 1904, by fever and a vivid redness of the entire right upper arm, which looked like erysipelas, at a time when the affected joint was as good as cured. The congestion bandage was removed, and the extremity elevated, whereupon the redness disappeared within two days. It is uncertain whether the increase in temperature, illustrated in the accompanying Chart XVIII., was due to the arm or to an angina which was present at the same time.

In those two cases we evidently did not have to deal with regular erysipelas. The redness was spread over too large an area for this ; it did not extend, and disappeared rapidly.

Most physicians have great hesitation in the use of congestion hyperæmia, because they cannot free themselves from the erroneous view, spread by textbooks on general and special subjects of medicine, that this procedure presupposes a disturbance of nutrition. Correctly applied congestion hyperæmia, however, does not mean disturbance, but improvement, of nutrition, as is demonstrated by the following case :

71. A farmer, sixty-one years old, contracted October 13, 1904, an injury of the left patella through a fall. November 1 violent pains appeared in the region of the left knee-joint, while the patient suffered from chills.

Patient was admitted November 3. The entire left leg was extremely swollen, especially at the region of the knee. This was exceedingly painful and tensely filled by an effusion. Aspiration of the joint showed pus, containing streptococci. The thigh showed an extensive lymphangitis.

The patient was in a miserable and emaciated condition, and had high fever. I considered the trouble to be suppuration of the knee-joint, and the enormous swelling of the entire leg as collateral swelling and œdema, produced by the suppuration of the knee-joint, for which reason I applied congestion hyperæmia. Here, too, the rapid effect on the pain was striking. The joint, which before the application of the bandage could not be touched without the patient screaming, could be passively moved the next day without eliciting any particular painfulness. The effusion of the joint greatly diminished very early ; but it appeared that the inflammatory swelling of the leg was due to something else. He had an extensive erysipelas, which rapidly extended on the trunk to the height of the ilium, leading to the formation of pus-filled vesicles and to circumscribed gangrene of the skin. It was striking that all phenomena of the erysipelas were more pronounced above than below the bandage. The patient died from sepsis November 8.

The anatomical diagnosis was : Erysipelas of the left leg, with partial gangrene of the skin ; suppuration of the left knee-joint ; intermuscular phlegmon ; partial gangrene of the muscles ; turbid swelling of the kidneys ; incipient nephritis septica ; bronchitis ; old pleuritis.

The condition of the left extremity was very striking. This part I cite from the report of the pathological institute. (I remark in advance that the mark of constriction mentioned in the report was caused by the rubber

bandage, which was worn twenty-two hours daily until death. As there were numerous pustules above the bandage, it had to be lately worn at the same place. For this reason it naturally left a " mark " in the intense œdema.)

" Somewhat above the middle of the left thigh is a pronounced constriction furrow. Skin, subcutaneous cellular tissue, and muscles, are divided by an incision alongside the femoral vessels, then following the saphena at places down to the bone. The opened knee-joint and bursa semimembranosa evacuate thick yellow pus. The synovial membrane of the knee-joint is dark red. Turbid liquid flows from the subcutaneous cellular tissue and the intermuscular tissue of the thigh, this turbidity appearing more pronounced above the mentioned constriction furrow than below. The muscular system of the thigh is partially (quadriceps, sartorius, adductors) discoloured into a greyish-yellow tint. For this, too, the constriction furrow forms a border of intensity. Above it the quadriceps and sartorius are yellowish-grey and almost entirely softened, so that parts of the muscles can be stripped off with the back of the knife; below the constriction furrow, this and the neighbouring muscles have retained their red colour to a much greater extent, while form and consistency of the fibres come nearer being normal. The border of this difference in the condition of the musculature, even in one and the same muscle, corresponds to the constriction furrow visible at the skin, and is sharply defined."

I also cite the microscopic report of the Bonn pathological institute:

" The muscles above, centrally from the constriction furrow, were almost entirely necrotic; below they were so only partially. The appearance of disintegration of nuclei was more pronounced above than below the furrow. The muscular fibres above the furrow appeared broadened, without shape, without transverse and longitudinal stripes, compressed into clumps, between which disintegrated nuclei are observed, which take the stain but poorly. Spaces not containing necrotic muscular fibres are relatively small. The necrotic places are surrounded by and contain large quantities of leucocytes, especially in the vicinity of the bloodvessels, which appear dilated and stuffed with leucocytes. Here and there white blood-corpuscles are observed in diapedesis. Erythrocytes, too, are found in large quantity in the vicinity of the vessels and in the intramuscular connective tissue. At several places of the specimens taken above the constriction furrow the muscle is completely transformed into masses of minute necrotic fragments and nuclei, traversed by connective tissue, and filled by leucocytes. Here also bunches of cocci are found in considerable quantity.

" On the whole, the muscle below the constriction furrow shows a greater quantity of erythrocytes. The vessels generally appear wider than above. Infiltration by leucocytes is considerable only in limited sections. Necrosis is far less than above the furrow, rather limited to a few small foci; but it does not reach here the degree of totality which it attains above the furrow. While above the furrow the transverse striation of the muscular fibres is noticeable only at a few places, below the furrow they show the most fibres."

We had to deal with a grave streptococcus infection, which had attacked knee-joint, intermuscular spaces, and skin of the leg. The indications on the skin were more strikingly shown by the musculature. When the incision was made through the soft parts, all the witnesses at the necropsy were struck by the enormous difference. Below the constriction furrow, sharply defined by it, muscu-

lature which appeared almost normal; above it extensive necrosis which can be at once recognized.

Now, I believe that here the remedy has saved the tissues from the threatened gangrene, not only by improved nutrition, which was produced by the congestion hyperæmia, but principally by the destruction of the bacteria and their toxins. But, at any rate, the undoubted proof is established that properly applied congestion hyperæmia does not mean disturbance of nutrition. To be sure, if we had applied the bandage too tightly the opposite would have occurred, and acute gangrene of the part of the extremity below the bandage would have taken place.

I will endeavour to disprove the important objection which has been raised against congestion hyperæmia in inflammatory diseases. Lexer[1] says: "It will give good results in mild cases; in grave cases it will fail perhaps always, and be doubtful in medium cases." If this were really so, the remedy would yet retain great theoretical importance for the estimation of inflammatory processes, because it removes all sorts of prejudices, but its practical value would be nil. But I do not believe it is necessary to seriously consider for any length of time Lexer's assertions. I shall omit the consideration of the inner improbability of such a schematic classification. One needs only to read in this book of the grave cases treated successfully, and also the discussion on congestion hyperæmia at the congress of surgeons of 1906.[2] Diverse speakers (Habs, Croce, Stich, Bardenheuer) have emphasized the fact that congestion hyperæmia has stood the test in *grave* acute inflammation. Other reporters give the same statements.

Lexer selects the worst example he can possibly choose by referring to phlegmons of the tendon sheaths. He says: "They (the tendons) may become necrotic, as do the sheaths, and naturally must be removed to arrest the suppuration from the fistula." Certainly the tendons can become necrotic under congestion hyperæmia, but how infrequently does this occur as compared with former experience! One need only study the chapter on phlegmons of the tendon sheaths in

[1] Lexer, "Zur Beh. akuter Entzündungen mittels Stauungshyperämie" (*Münch. Med. Wochenschrift*, 1906, No. 14).

[2] Transactions of the Thirty-fifth Congress of the Deutsche Ges. f. Chir., 1906, vol. i., pp. 220-266.

this book, and read the reports of other physicians, who almost uniformly tell us that a favourable turn has been produced by congestion hyperæmia, some of whom even report better results than I. ("The results of the treatment of phegmons of the tendon sheaths with congestion hyperæmia and suction are truly brilliant, and if this method had accomplished nothing else than this, it would merit not to be forgotten."—Bardenheuer at the Thirty-fifth German Congress of Surgeons.)

Until now we have considered V-shaped suppuration of the tendon sheaths and of the tendon sheaths of the small fingers among the gravest and most dreaded phlegmons. In those, too, congestion hyperæmia has shown itself of brilliant efficiency.

Lexer thinks that the solution of the bacteria will liberate a large quantity of endotoxins, which most seriously injure the tissues. I do not know enough of bacteriology to pass an opinion on endotoxins and their effect, but I can assert this much, that in spite of a wide experience I have not observed the terrible effect of the endotoxins which Lexer so very much fears.

Things are similar with the rapid suppuration of inflammatory infiltrations and the rapid spread of the suppuration, claimed by Lexer. I have never seen it in the manner described by Lexer. Lexer has entirely misunderstood me, for he asserts that I cling to the principle of small incisions. Where have I ever asserted it? *As a rule* I make only small incisions, because, like many other surgeons, I find them sufficient with the aid of congestion hyperæmia, and shall adhere to them until I have bad experience with them. If a suppuration spreads rapidly, naturally large incisions must be made. I consider it even a technical error to permit an abscess to become large under congestion hyperæmia. The diagnosis of a fairly large abscess can be made even under congestion hyperæmia. In my opinion the indication for incisions is very simple. One should always try to manage with small incisions where large ones would disturb function —therefore in suppuration of tendon sheaths and joints. In the majority of other cases the size of the incision is of but secondary importance. Whoever cannot succeed with small incisions may surely make large ones.

I cannot agree with Lexer that inflammatory infiltrations should be incised before the institution of congestion hyperæmia, in order to wash out the toxins. A similar proposition was made me by Klapp, and he has carried this idea into practice on a large number of tuberculous patients in the Bonn polyclinic. He opened the tuberculous granulation foci and tried to remove the toxins by means of suction apparatus, and at the same time to hyperæmize the granulations. In this I did not concur with him. I rather promise myself much more from my first experiments which I undertook with abscesses, treated by congestion hyperæmia. I opened them very freely, thoroughly removed the pus, and closed the large wound with silver-wire sutures placed widely apart.

Lexer warns against many other things—for example, motion of inflamed extremities, squeezing out of the pus,[1] application of congestion hyperæmia in lymphangitis—because, in his opinion, all sorts of things are apt to happen. He explains: "Whatever may possibly be followed by fatal consequences must be excluded from treatment!" In my opinion, adherence to such a principle in medicine, and especially in surgery, excludes any therapeutic progress. What is it that may not have obnoxious consequences, especially according to the views of colleagues sworn to certain doctrines! I believe I do not exaggerate when I assert that the greatest majority of the surgeons to whom the question would have been submitted some time ago, whether congestion hyperæmia can be harmful in inflammation, would have answered that it could do *nothing else but harm.*

I prefer to rely on experiences, gained with great care and precaution, and these only lead me, not what I consider merely theoretically. By this I do not intend to deny that theories are the best indicators of facts.

I deemed it necessary to reply somewhat fully to Lexer's statements. For his views are essentially based on theoretical bacteriological conceptions. But I have repeatedly found from experience that our modern physicians esteem them so highly that clinical experience is relegated to the

[1] I emphasize here again that all these procedures must be made so delicately that the patient must not experience any inconvenience. It seems to me that my suggestions have been construed as though I permitted the suppurating tendons to practise gymnastics.

background. I refer the reader to what I have said in the section on Gonococcic Arthritis. Any kind of serum is easily made popular, as long as it has a "scientifically bacteriological basis," but the simplest remedy, proved by clinical experience to be reliable, is resisted. Among the contra-indications which have been mentioned in acute inflammation, I first name

Streptococcus Infections.

I have myself stated repeatedly that my experience on this subject is limited, owing to the great rarity of streptomycosis in Bonn. Meanwhile our experience has been increased, and observations of others have been published.

As regards erysipelas, I have already said, in the chapter on its treatment, that the views of physicians on the value of congestion hyperæmia are variable.

Meanwhile v. Brunn,[1] Habs,[2] Heller,[3] and several others, have described cases of undoubted erysipelas which occurred on acutely inflamed extremities which were under the influence of congestion hyperæmia.

v. Brunn observed, in sixty-five cases of acute suppuration which he had treated with congestion hyperæmia, six cases of erysipelas. Habs saw one out of seventy selected grave cases. I myself saw two genuine cases of erysipelas after congestion hyperæmia therapy.

72. A young man, sixteen years old, was admitted to the Johannis hospital, November 22, 1905, for a grave recurrent osteomyelitis of the left tibia. One abscess containing staphylococci, and later another containing staphylococci and streptococci, were divided by a small incision, and the disease treated with congestion hyperæmia. With this treatment erysipelas developed on the foot, which ascended to the thigh without reaching the constrictor, which was continued. This occurred December 5, and five days later the erysipelas was extinguished under continued congestion hyperæmia treatment. I removed later from the tibia by chiselling a large and a small abscess.

A second case of erysipelas which developed under congestion hyperæmia in a case of grave pyæmia is described under No. 74.

[1] v. Brunn, "Über die Stauungsbeh. bei akuten Entzündungen nach d. bisherigen Erfahrungen d. v. Bruns'schen Klinik" (*Beiträge z. Klin. Chir.*, vol. xlvi., No. 3).

[2] Habs, "Erfahrungen mit Bier'scher Stauungshyperämie bei akuten Eiterungen" (*Wiener Klin. Rundschau*, 1905, No. 46).

[3] Transactions of the Thirty-fifth Congress of the Deutsche Ges. f. Chir., vol. i., p. 247.

These are the only two cases of genuine erysipelas which I have observed in many hundreds of cases of acute suppuration and in an equally large number of acute inflammation.

All cases of erysipelas observed terminated in recovery.

There is no doubt, from these observations, that congestion hyperæmia is unable to prevent a fresh erysipelas ; nay, it seems from v. Brunn's cases that this agent even favours the appearance of this disease, for v. Brunn found almost 10 per cent. of his cases complicated by erysipelas. The presumption is readily reached that congestion hyperæmia has a different effect in etiologically different cases. My own experience is practically limited to staphylomycosis. The favourable influence of congestion hyperæmia on this disease is unquestionable. The same holds good also for gonorrhœic metastases and for the osseous metastases in typhoid fever. I saw two cases of the latter heal promptly under the influence of our remedy. Now, it might be possible that our and Hochhaus's cases of erysipelas, which, as I have described above, have apparently been favourably influenced by congestion hyperæmia, have run such a favourable course, not because, but in spite of the remedy, and that the latter has a favourable effect on infection with staphylococci, typhus bacilli, and gonococci, but is ineffective against streptomycosis. Against this view, however, witness a series of our observations, such as Case 26, where we succeeded in making an abscess cold produced by streptococci ; Case 71, where grave gangrene produced by this germ was strikingly limited and prevented so far as the constrictor could reach, and several cases of rapidly cured suppuration of the middle ear complicated by mastoiditis, in which, too, streptococci were found. Recently we have observed a rapid and complete cure in the following four cases of streptomycosis by means of congestion hyperæmia : osteomyelitis of the femur —it healed without necrosis ; three phlegmons of tendon sheaths, one of which grave, all healing without necrosis. In a series of open cases were found staphylo- and streptococci. These cases, which came under treatment with open abscesses, naturally cannot be utilized.

Other authors, too, have reported numerous cases of streptomycosis which have healed under congestion hyperæmia

therapy. I therefore believe that in principle the hyperæmia plays the same rôle in regard to streptomycosis as it does to other infections, and that in the cases where erysipelas occurred under the treatment a not yet recognized error in technique was made. I am strengthened in this view by my earlier experience in open tuberculosis which I have collected. I have mentioned in the chapter "Treatment of Tuberculosis" that in 1893 I observed, discouragingly often, grave acute infections, and especially erysipelas, after the use of the congestion bandage. I soon recognized that this was due to a faulty technique—that is, congestion hyperæmia continued too long, producing pronounced chronic œdema. As soon as I altered the technique I no longer had a single case of erysipelas since 1894, in spite of the enormous number of cases of tuberculous extremities which I have treated.

If I am asked where the technical error is, I must now find an answer. Probably here, too, the old and used-up œdematous liquid is to be held responsible. We know from numerous observations that in itself it favours the development of erysipelas.

Again, the circumstance that *one* observer saw in the small number of sixty-five cases about double as many cases of erysipelas as all others combined, with a larger material, shows plainly enough that the peculiarity of technique plays a great part.

One must remember that the entire treatment is still very recent, and that the technique cannot possibly have been fully developed.

According to Sick,[1] on the other hand, congestion hyperæmia acts "positively deleteriously in the grave subcutaneous streptococcus phlegmons." We observed diverse cases in which extensive gangrene of the skin occurred.

Nordmann[2] made similar observations in phlegmons of the fascia which have been produced by streptococci. Nordmann believes that these failures can be explained by the unfavourable conditions of nutrition of the fasciæ, as in them a pronounced hyperæmia cannot be produced. He is

[1] Transactions of the Thirty-fifth Congress of the Deutsche Ges. f. Chir., p. 226.

[2] Nordmann, "Erfahrungen über Stauungshyperämie bei akuten Entzündungen" (*Med. Klinik*, 1906, No. 29).

of the opinion that in his cases the congestion hyperæmia has done no harm, but that extensive incisions performed early would have more rapidly led to their cure.

Diabetes.

Several authors have advised against the application of the congestion bandage in diabetes. The published cases are so free from objection that we must assert that the remedy in such cases is contra-indicated, or at least recommend its very careful use, though favourable observations have been made. I will refer to this in another chapter, in which the treatment of diabetic gangrene by means of hyperæmia will be dealt with.

Hæmorrhages.

I have often been asked whether congestion hyperæmia does not increase the danger of secondary hæmorrhages from wounds, ulcers, and sinuses. I can answer this question in the negative according to my experience. I have seen secondary hæmorrhage in but one out of the many cases treated. This relates to a V-shaped, septic phlegmon of a tendon sheath of the hand of a labourer, who suffered twice from a moderate hæmorrhage from an incision wound made by us. But the congestion hyperæmia was quietly continued, and led to a brilliant success. It not only preserved the life of the tendons, but cured the hand with perfect function.

Hæmorrhages from septic wounds are by no means rare even without congestion hyperæmia.

Abscesses and Decubitus at the Place where the Bandage had been applied.

Leser[1] has reported a case in which the constrictor has produced harm. It was a case of pyæmic metastases in a foot and shoulder-joint in one and the same individual. The pyæmia had its origin in suppurating wounds of the head. Leser treated both joints with the constrictor, but had to remove it very soon, because it produced intense pain at the site of constriction. Later, at the very place

[1] Leser, "Ueber eine Beobachtung im Gefolge der Bier'schen Stauungshyperämie bei akut eitrigen Prozessen" (*Zentralblatt f. Chir.*, 1905, No. 17, p. 470).

where the bandages had been applied, abscesses developed. A similar case is reported by Stich.[1] Leser assumes that the bandages have damaged the compressed tissues and have created a locus minoris resistentiæ, at which organisms circulating in the blood could find a place for accumulation.

Leser's definition is very lucid, and it is advisable to be cautious in similar cases. Nevertheless, the danger does not appeal to me as being very great, for with the exception of Leser and Stich neither I nor others have seen anything like it in a representative series of grave acute general infection; and that it need not occur is evidenced by Case 74, to which I refer, where congestion bandages have been applied to various parts of the body.

In addition to the above-described two cases of erysipelas, we experienced a more serious, transient damage in Case 16, where we had to deal with an acute osteomyelitis of the upper arm with suppuration of the shoulder-joint, and that was plainly due to a technical error. In this case the constrictor produced decubitus of the axillary cavity, which required a long time to heal. Fortunately, this did not spoil success, because we had to deal with a case where the congestion hyperæmia very rapidly suppressed the infection and its consequences. Congestion hyperæmia of the shoulder-joint offers very great obstacles in acute suppuration. I believe, however, that, warned by that case, we shall have no more such experience, for one need only occasionally remove the constrictor in order to prevent decubitus.

Venous Thrombosis.

Habs[2] saw a case of inflammation of the lung following an aseptic gunshot wound of the knee-joint with venous thrombosis, which he conceived to be embolic. According to this, venous thrombosis should be a contra-indication for congestion hyperæmia. I shall presently report that the same holds good for the hot-air treatment of *recent* thrombosis.

Heller[3] treated successfully a case of gangrenous erysipelas of the arm. Post-mortem examination of the man, who

[1] Transactions of the Thirty-fifth Congress of the Deutsche Ges. f. Chir., vol. i., p. 228.

[2] *Ibid.*, p. 220.

[3] *Ibid.*, vol. i., p. 248.

died of pneumonia, showed that all the veins of the arm which was treated with the bandage were thrombosed.

Robbers[1] treated for a brief period a case of severe pneumococcic infection of the hand with congestion hyperæmia. Gangrene followed, and the forearm had to be exarticulated. The vessels of the latter were thrombosed. Robbers is undecided whether the pneumococcus infection or the constrictor caused the gangrene. There was pronounced swelling before the application of the constricting bandage.

Fatal Cases in Patients treated with Congestion Hyperæmia.

It is of special importance to examine the fatal cases which occurred during or after the treatment with congestion hyperæmia, with a view to ascertaining whether the applied remedy was at fault. For this reason I shall give an exact report of the cases we have observed, to which must be added the one described under No. 71.

73. A servant, aged fourteen, took ill on April 15, 1904, with chills and intense pains in the right leg. He soon became delirious, and showed phenomena of loss of consciousness. He was admitted April 24, 1904. He talked incoherently, and did not reply to questions. Respiration and pulse were extremely accelerated; the temperature (measured in the axilla) fluctuated between 39° and 40° C. The right leg was enormously swollen, red, and œdematous. Extensive fluctuation could be felt. Under ether intoxication the regions of the upper and lower ends of the tibia were opened by incisions 2 centimetres long. Pus in large quantity, containing fatty drops and showing staphylococci, was evacuated. The pus was removed as much as possible by irrigation with hot saline solution. Congestion hyperæmia was instituted. The condition of the neighbouring joint could not be estimated, because of the enormous œdema. The patient's condition for a short time improved in so far as that the sensorium became freer, he understood questions, answered them, and then fell back into his old stupor. The suppurating ankle and knee joints of the leg were aspirated and irrigated; the tibia, which was entirely denuded of periosteum, was chiselled open throughout its entire length; and finally the right thigh was amputated. The patient died May 2. Post-mortem examination showed embolic pus foci in lungs and kidneys, hepatization of the lower lobe of the right lung, suppuration of the right sterno-clavicular joint, and incipient anterior mediastinitis.

Without doubt the patient was septic and pyæmic when he was admitted. It would have been best either not to treat him at all, or at any rate to at once perform amputation.

[1] Robbers, "Pneumokokken- oder Stauungsgangrän" (*Deutsche Med. Wochenschrift*, 1906, No. 16).

74. A child, one and a half years old, became afflicted with severe sepsis following a burn blister.

It was admitted to the clinic July 17, 1906. It was a pale but otherwise strong child, with dry tongue, parched lips, and hectically flushed face. The principal symptoms were a pronounced meteorism, profuse diarrhœa, which were so frequent that the child was continually in fæcal matter. The temperature ranged between 40° and 41° C. (measured in axilla).

In front of the right tibia, below the tuberosity, there were all signs of an intense inflammation. The diagnosis made was: Acute osteomyelitis of the tibia, with general sepsis.

Incision 3 centimetres long through the inflamed part removed about a teaspoonful of thin bloody pus, much less than we anticipated. The pus contained streptococci. The tibia below the abscess was denuded of periosteum to the extent of about 1½ centimetres. Congestion hyperæmia was instituted. The diarrhœa persisted.

July 23 an erysipelas developed below the constrictor at the right leg, which rapidly progressed to the trunk. As the suppuration of the tibia had fairly ceased, and the erysipelas had passed over the constrictor, congestion hyperæmia was discontinued July 25. August 3 erysipelas had ceased.

August 5 appeared the first signs of thrombosis of both iliac veins. The following metastases appeared successively: In the middle ear, in the right elbow-joint, in the right shoulder-joint, in the right eye (iritis). The joints were opened by small incisions, and for both, as well as the head, congestion hyperæmia was instituted.

The child died August 17. Section showed thrombosis of the vena cava and of both iliac veins. In the latter the thrombus was decomposed by suppuration. Suppurative metastases in the right shoulder, elbow, and hip-joint, at the ribs, in the lungs, in the pleura, in the myocardium. Suppurative iritis.

The right tibia was denuded of periosteum at its anterior surface to the extent of one and a half finger-ends. The bone was sawed through longitudinally. Throughout healthy marrow was found. The wound at the tibia was in the best condition.

The middle ear was not opened.

Post-mortem examination established that our diagnosis —osteomyelitis—was false. The focus at the tibia, which we had divided, was nothing more than a small subperiosteal metastasis, which according to our old rules was more than sufficiently opened by a 3-centimetre incision. Otherwise it might have been said that we had failed to chisel open the medullary canal, and thus caused death. It was a case of intense general infection from the very beginning. That the child stood it for a month is to be wondered at.

Nor did the remedy have anything to do with the thrombosis of the vena cava and of both venæ iliacæ, for their first signs appeared eleven days after cessation of the congestion hyperæmia at the leg.

75. A man, forty-nine years old, sustained eight days ago a wound of his right index-finger, to which he paid no further attention. May 25, 1905,

the right arm suddenly became intensely swollen, there appeared red stripes on the skin, the region of the elbow and of the axillary cavity were painful. For this reason he was admitted to the clinic May 26.

The entire right arm was œdematously swollen and felt hot. The thickly swelled fingers were fixed in flexion, and were but little movable. At the index-finger was a small, almost healed granulating wound. Cubital and axillary glands were swollen and painful. In the skin of the arm, broad, reddened lymphangitic strands were visible. The man gave the impression of one who was very seriously ill, and was so excited that we had to administer an injection of morphia. A constrictor was applied to the right arm as high as possible May 27, which produced intense redness, swelling, and three blisters. The general condition was better, and the patient had lost his pains. May 28 the general condition became worse again. At the extensor side of the arm eight new blisters filled with serum made their appearance. In the evening the patient was again much excited, and died suddenly during the night.

It is to be regretted that the post-mortem only records: "Anatomical diagnosis: Stenosis of the aorta, hypertrophy of the heart, scars of the kidneys, phlegmon at the right upper arm." I am therefore compelled to quote from memory the detailed findings of the section, which, however, can be accepted as correct, as there were several physicians present who endorsed them.

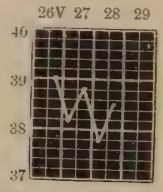

CHART XIX.

On cutting into the intensely swollen upper arm, gelatinously infiltrated subcutaneous cellular tissue appears, which is filled with small pus foci in the region of the large lymph strands. The largest of them is situated just above the elbow-joint. No thrombosis of vessels is found throughout the entire arm, and especially not at the place where the constrictor had been applied.

Besides this, a pronounced stenosis of the aorta (the lumen was only as thick as a goose-quill) and pronounced hypertrophy of the left ventricle were found.

The post-mortem examination revealed that the incision of an abscess had not been neglected, for the small abscesses present were so diminutive that they could not have been found during life, and at best their opening would have availed nothing. The pronounced aortic stenosis explains the sudden death in an acute infectious disease.

76. A child, one and three-quarter years old, was admitted to the clinic July 11, 1905, seriously ill with a phlegmon at the right inner angle of the eye, which was incised, in addition to which it was treated with a congestion bandage placed around the neck. July 16, after a transient improvement, the patient began to suffer from spasm and other cerebral

symptoms. The congestion bandage was therefore discontinued. The child died July 21.

Post-mortem showed in the right frontal brain a tumour larger than a hen's egg, which was cystically softened at the centre, while its periphery consisted of a grey-white, fairly firm tissue. This tumour tissue is necrotically softened, partially "doughy" towards the central cyst. The tumour cannot be sharply defined from the brain substance. It continues, furthermore, forward and behind to the ethmoid bone and through it into the nasal cavity as a ragged, pulpy mass. It does not extend into the orbita. At both sides pronounced hydrocephalus. Anatomical diagnosis: Glioma of the frontal brain.

During the life of the child the brain tumour had produced no symptoms which would have enabled its diagnosis, which is easily understood when we consider its site and the age of the child. The softened and suppurating tumour had perforated outwards, and created the impression of an intense phlegmon of the face. I scarcely need emphasize that the congestion hyperæmia which had been applied for a few days had nothing to do with the death of the child.

The death of Case 62, of abscess of the brain, cannot be attributed to the constrictor. It had been worn altogether five days up to the surgical operation. To this must be added the fact that the congestion hyperæmia relieved the patient to such an extent that any physician operating at that time would have been satisfied to clean out the middle ear, and would hardly have exposed the brain lobe of the temple. Finally, the brain abscess was opened comparatively early, as soon as suspicious symptoms appeared. Post-mortem examination also did not show anything that could have been so interpreted that the applied remedy could be held responsible for any harm done, especially not for meningitis or perforation into the ventricle.

77. A child, one year old, was admitted and operated for incarcerated hernia, January 20, 1905. In addition it had a chronic suppurative otitis media (double), which, according to the parents, had appeared soon after birth. The middle-ear suppuration was treated with congestion hyperæmia. The child became afflicted with pneumonia, was transferred to the medical clinic, where it later died. The post-mortem examination, made March 13, 1905, showed a double-sided catarrhal pneumonia as the cause of death.

Here, too, the lethal end had nothing whatever to do either with the middle-ear suppuration or with the congestion hyperæmia.

78. A labourer, forty-five years old, was admitted to the surgical clinic, April 30, 1906, seriously ill. An exact anamnesis cannot be obtained, as

his mind is not clear. He finally stated that he has had intense pains in the right ear for the past four days.

As there was no discharge from the ear, and as the tympanum was intensely reddened, paracentesis was at once performed, which removed pus profusely. The following day the following condition was noted: The patient gave the impression of one gravely ill and emaciated. Both tympani are intensely reddened and swollen, but nowhere arched forward. Ill-smelling serous pus is discharged through the paracentesis wound. In the left tympanum a small opening can be noticed centrally. On irrigating the ear the fluid to a great extent enters the naso-pharyngeal space. The greatly diminished ability to hear as compared with the local condition was very striking. Nothing abnormal could be detected at the mastoid processes.

Examination of the lungs showed the presence of catarrh. The lips had herpes. Temperature, 40° C.

Congestion hyperæmia of the head was applied, but was poorly tolerated by the patient. It had to be frequently removed, and was discontinued after four days. The treatment was limited to irrigating the ears, which discharged but little. The physical signs of the ears and lungs did not change, the temperature remained high, and the principal symptom was great depression.

As there were no signs of meningitis, sinus thrombosis, or brain abscess, we were under the impression that we had to deal either with an otogenous sepsis or miliary tuberculosis. We also considered the possibility of a central pneumonia. My medical colleague, who was consulted, could not demonstrate it, but thought it possible.

The patient died May 7. The dura was tense and translucent, pia turbid and translucent, tentorium covered with fibrinous, yellowish-green exudates. The right transverse sinus was filled with greenish, dirty, soft material, which clung to the wall. Sinus longitudinalis and transversus were free. After removal of the dura the lower half of the petrous portion of the temporal bone appeared greenish-grey and yellowish. In the cells of the mastoid process and in the middle ear was found a bright yellow puriform pulp. There was also extensive bronchitis.

This case has given us much thought on account of the diagnosis. As all symptoms of a meningitis or brain abscess were wanting, the grave general condition compelled us, with the aid of Eschweiler, to diagnose otogenous sepsis or a miliary tuberculosis, starting from a tuberculosis of the petrous portion of the temporal bone. For this reason we expected nothing from an operation, and did not perform one, even after the congestion hyperæmia had been discontinued.

Then I wish to report from memory a case of death which occurred six or seven years ago in Greifswald.

79. An elderly man was admitted with a bad infection of an entire arm and with the symptoms of a grave sepsis. I applied congestion hyperæmia. The man died of sepsis. I am sorry that I could not obtain the clinical history, and I do not recollect all details. This much I remember—that the congestion hyperæmia was an experiment in a hopeless case, and that it had nothing whatever to do with the death, as was proven by post-mortem examination.

Thus I am in the fortunate position to be able to affirm that in acute inflammation and suppuration, apart from the yet imperfectly explained erysipelas, we have had among all our cases none in which congestion hyperæmia in acute inflammation has produced serious harm, or could with any probability be looked upon as the cause of death. That this will always continue I do not assert. It is not even probable. For, with every new method of treatment one has to learn by experience, and the more important curative methods have not been introduced without loss of health and life. How many cases of carbolic acid poisoning have been caused by antisepsis! It is not even necessary to restrict oneself to such great pioneer agents. The same holds good for almost any method of operation. How many victims in life and limb have been sacrificed by so apparently simple a procedure as reduction of the congenitally luxated hip-joint before it has been brought to its present state of relative safety!

And I emphasize again that one must not think that the introduction of congestion hyperæmia will arrest death from septic infection, and it should not be forgotten that in suppuration endangering life the value of life is to be more highly rated than that of the attacked extremity. I have tried to treat suppuration with small incisions for the purpose of securing better function, but this, too, has to be sacrificed when life is endangered. In such cases the incisions should be extensive, and, if need be, the limbs should be amputated. No doubt, in such conditions, the time at which amputation is to be performed depends on the view and experience of the individual surgeon, and is a matter even of temperament. I personally have a decided antipathy for all surgical procedures which mutilate or disfigure the patient, and am therefore extremely conservative in such cases where the danger exists.

Congestion hyperæmia should be desisted from in cases of grave pyæmia in which the general condition does not improve, or even gets worse, *especially* when the extremity, in spite of correctly applied technique, does not show appreciable reaction to congestion hyperæmia.

TREATMENT OF ACUTE INFLAMMATION AND SUPPURATION BY MEANS OF CUPPING-GLASSES AND SIMILAR SUCTION APPARATUS

Cupping-glasses and suction apparatus, which I frequently use for purposes of hyperæmization, were employed by me for acute inflammation several years ago in Kiel and Greifswald, but only for the treatment of furuncle. My intention was not only to produce hyperæmia, but also to suck out with the thinned air the pus and necrotic shreds, which I succeeded in doing. Tilmann especially, at my instigation, made extensive experiments in this direction at the Greifswald polyclinic. But he was not specially satisfied with the results. He found the appliances too painful for the patients, and the hyperæmia produced by them too energetic. Tilmann's experience has caused me to abandon this treatment of the furuncle. Of late, however, Klapp has resumed the treatment in the Bonn polyclinic, has extended it to all possible forms of inflammation and suppuration, and has so fully developed the technique that he can show excellent results in this domain. According to Klapp's rules, the cupping-glasses are applied daily for forty-five minutes in acute local inflammation and suppuration. During the séance the treatment is arranged approximately thus: the glass is allowed to remain five minutes over the seat of inflammation, and is then removed for three minutes.

Klapp advises the application of a layer of fat around the seat of infection or inflammation (furuncles, carbuncles, etc.), in order to prevent inoculation of the neighbouring hair follicles. For the same reason the entire region is carefully cleansed with benzine before and after treatment.

In acute inflammation the glasses must be applied with but little thinning of air. In this way only is it possible to avoid unnecessary pain and to attain the correct degree of hyperæmia.

The local acute forms of inflammation which so far have been subjected to this method of treatment (suction) are: Furuncle, carbuncle, buboes, acute abscesses, mastitis, infiltrations, infected, recent, and old wounds, granulation

places whose granulations were not bright red, insect stings, panaris, paronychia, phlegmon at the floor of the mouth, etc., in large number.

In infiltrations, dirty, recent, and older infected wounds, panaris, and, in fact, all affections where there was inflammation but no abscess, suction treatment was applied in the manner described.

All abscesses were opened, preferably under ethyl-chloride spray.

The duration of treatment is much shorter than that of our other methods. Furuncles as a rule heal in five days, carbuncles in ten to fifteen days, nothing else, except the suction treatment, being done beyond the removal of the top from the individual plugs by means of catch-forceps or by snipping off with scissors.

Furuncular abscesses were opened by a small incision. This should be done especially in the sweat-gland abscesses of the axilla, and the pus should be thoroughly removed by the suction-glass without delay.

Diabetic furuncles and carbuncles, according to our experience, rapidly improve under this treatment. To be sure, they heal somewhat slower, and occasionally the treatment is protracted, because new ones constantly form.

Grube,[1] who enjoys the advantages of experience with large numbers of diabetic furuncles and carbuncles, owing to his special practice in Neuenahr, speaks favourably of the treatment with suction apparatus. He says: "I can only emphasize the fact that the method has great advantages over older ones, mainly because it is more delicate, produces a cure more rapidly, and, in grave cases, apparently protects against the appearance of coma." Very good results in diabetic carbuncle are reported also by Croce.[2] Colley,[3] however, warns against the treatment of diabetics with constrictor and suction apparatus. In two

[1] Grube, "Die Anwendung der Hyperämie nach Bier bei einigen Erkrankungen der Diabetiker" (*Münch. Med. Wochenschrift*, 1906, No. 29).

[2] Transactions of the Thirty-fifth Congress of the Deutsche Ges. f. Chir., vol. i., p. 224.

[3] Colley, "Beobachtungen und Betrachtungen über die Behandlung akut eitriger Prozesse mit Bier'scher Stauungshyperämie" (*Münch. Med. Wochenschrift*, 1906, No. 8).

grave diabetics, one suffered gangrene of the skin from the constrictor, and in the other the gangrene of the skin, for which congestion hyperæmia had been applied, rapidly enlarged. The treatment of carbuncles with the suction-bell produced in one a large abscess with gangrene of the skin, and in the other a gangrenous circle corresponding to the margin of the bell.

The experience of Colley teaches caution, in spite of the excellent results obtained by others. At any rate, in diabetic carbuncles the rarefying of the air should not be pressed too far.

The following case, which has been treated in the Bonn clinic, shows how rapidly a grave case of carbuncle can heal under suction treatment :

80. A man, fifty-three years old, was admitted, March 28, 1905, with a carbuncle over the right spine of the ilium, of the size of the palm of the hand. The carbuncle was in part covered by pustules, partially filled with necrotic plugs. The vicinity of the carbuncle showed extensive bluish discoloration. The unopened pustules were robbed of their covering cuticle by means of the scissors. A large suction-bell was applied and placed in activity. The pus streamed through the various holes as from a watering-can. Suppuration ceased April 4; but as fluctuation was plainly felt beneath the skin, an incision puncture was made, in the belief that there was a subcutaneous abscess. The suction-bell, however, removed only a small quantity of dark liquid blood, which showed no inclination to coagulation.

The patient was discharged cured April 8.

This pronounced carbuncle, therefore, healed in eleven days. Accidentally the patient proved an excellent means for determining the comparative value of the diverse methods of treatment. Eight weeks previous to admission a similar carbuncle on his back had been incised, which had not yet healed when he was discharged. *On the other hand, the dangerous furuncles of the face, in our experience, heal far better under a congestion bandage applied to the neck than by means of cupping-glasses.*

Subcutaneous and periosteal panaris, if one does not prefer the congestion bandage, is rendered hyperæmic by means of the suction-glass, illustrated in Fig. 19, constructed by Klapp. It represents a small edition of our large suction apparatus. This finger-glass is shaped to the finger, has a large opening for the finger and a small one for thinning the air.

The air-tight occlusion is produced by a rubber finger-stall

the top of which is cut off. One can in that way select a more or less wide finger-stall to suit the thickness of the finger, and can make the opening in the stall to any desired size. Rarefying of the air is accomplished by a rubber ball, which is attached while compressed. The change of the atmospheric pressure is accomplished in the manner described. The patients can attend to that themselves by allowing the rubber ball to become filled and by compressing it after a while.

Klapp has successfully treated dental sinuses with the cupping-glass. The carious tooth is removed, and if there is no sequestrum of the jaw the fistulæ heal rapidly, and, what is more important, without being followed by a disfigurement, which cannot be said of the sinuses that heal spontaneously. For they often cause deeply-drawn-in,

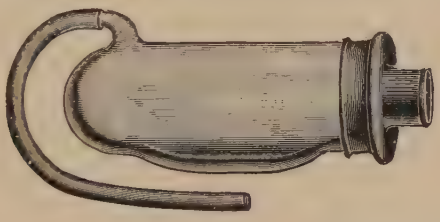

Fig. 19.

ugly scars, adherent to the bone. For this reason it was customary with surgeons to excise the fistulæ and to suture the wound margins. The cupping-glass, however, draws out the sinus and its surrounding, and thus prevents the drawn-in scar. The good results in dental sinuses have been confirmed by members of the dental profession.[1]

We and others (Frommer, Lossen, Käfer, etc.) have had good results in the treatment of all sorts of fistulæ which remained after operations, especially those due to suture infection. The threads afterwards become encapsulated, or the cupping-glass sucks them out.

Suction treatment in acute suppuration has two great advantages over congestion hyperæmia with the bandage :

1. It removes the pus thoroughly, and produces an effective, in many respects different, form of hyperæmia.

[1] J. Witzel, " Die Bier'sche Stauung u. deren Anwendung als Heilmittel in d. Zahnheilkunde " (*Zahnärztl. Rundschau*, vol. xiv., Nos. 19, 20, 21, 22).

2. Possibly it is without danger even in the hands of the inexperienced and less skilful, which cannot be said of hyperæmia by constriction.

To be sure, the cupping-glasses, too, may be falsely applied. This can be seen from the fact that our own first attempts were not followed by any brilliant results. For this reason we again state : The suction appliances should be applied mildly in acute inflammation, and must produce neither pain nor hæmorrhages. The air is to be thinned just enough to enable the appliance to adhere to the skin. In tuberculous affections, however, increased thinning of air is not only permissible, but even useful. In the polyclinic the patients themselves soon know which physician applies the cupping-glasses correctly—*i.e.*, gently—and which falsely —*i.e.*, firmly and with a firm hand.

In abscesses it is not sufficient to suck away the pus ; for a cure a prolonged and careful hyperæmia is essential. This becomes evident from the singular attempts of physicians in the past to suck up the pus with cupping-glasses not having found any imitators, and in that it never became a recognized method of cure. We find a few brief remarks that one or another physician has availed himself of cupping-glasses in abscesses. Thus, we read in Nicolaus Florentinus,[1] in the description of buboes, the remark that, in addition to plasters, poultices, and other remedies, is to be considered "extractio puris cum incisione et suctione, *i.e.*, cum ventosis et cum eis, qui trahunt pus post sectionem et apertionem."

I describe the treatment of acute puerperal mastitis as a paradigma for the suction method. It is suitable for all stages of this disease, for the beginning inflammation and developed abscess, as well as for old, suppurative fistulæ and cicatricial indurations.

For mastitis a suction-bell (Fig. 11, *g* and *h*) is applied, the diameter of which is about 2 to 4 centimetres smaller than that of the mammary gland. The bell may have an even margin, but it is better if it have one cut to correspond to the form of the chest wall. The patient presses the apparatus against the chest, and keeps it so during the séance. On rarefying the air with a suction syringe or rubber ball, it

[1] Gurlt, "Geschichte d. Chir.," Berlin, 1898, vol. i., p. 823.

can be observed that the mammary gland is more and more drawn into the bell. It assumes a bluish hue and becomes filled with blood. The cutaneous veins swell. The patient finally has a sensation as "if the breast would burst." The rarefying of the air must stop at this stage. *The entire procedure must be painless.*

In recent cases about 30 to 60 c.c of milk are discharged through the nipple ; abscesses and sinuses yield at first blood and pus, and at the end of the séance bloody serous fluid. Stased milk should be thoroughly removed. If the large bell does not suck up enough, the well-known small breast-pump is to be used. To remove the milk by suction, it is practicable to make use of the longer bell with smaller diameter illustrated in Fig. 11, *g*. The breast being sucked into the bell, it is compressed by it laterally, and milk is thus pressed out.

The pain-relieving effect of hyperæmia is striking also in mastitis. Women who have had no rest during the night because of the intense pain sleep undisturbedly the night after the first séance. If the pain does not disappear, there is usually an abscess present needing incision. The fact that there is still pain present can be looked upon as a diagnostic feature in that respect. The reverse conclusion is not permissible, for occasionally abscesses existed without pain under the suction treatment.

Abscesses are always to be incised in the manner described for other forms of suppuration—that is to say, by an incision $\frac{1}{2}$ to 1 centimetre long, under a spray of ethyl-chloride. The small incisions are of special importance, because in the mammary gland scars and loss of glandular substance are to be avoided. *Pus must be thoroughly removed every time.* Occasionally it may prove practicable to make use, in addition to the large bell, of the ordinary cupping-glass, which frequently removes the pus more thoroughly and in a better manner. As soon as this small instrument with its local effect has removed the obstruction, the large suction-bell again evacuates pus freely. This must be tried in every instance.

Before each new séance care must be taken to ascertain whether the incision opening has been displaced. Scabs which occlude are removed with forceps or a probe ; deeper

obstacles are removed by a slender dressing forceps, carefully introduced into the abscess cavity. Stich[1] has observed several times that in spite of these measures no pus escaped during suction. On the other hand, a stream of pus was procured if the suction-bell was applied over a small drainage-tube properly placed in the cavity. He advises for these cases, in which evidently intense granulation masses act as a sort of valve closure, the insertion for a few days of a small drainage-tube. We have found this advice valuable.

Newly developing abscess should not lead to the premature abandonment of the treatment, and to its being replaced by major and mutilating operations. We have seen cures, without deformity, in cases where we have opened eight to ten abscesses successively by small incisions.

At first the suction-bell is applied forty-five minutes daily in such a way that hyperæmization is made for five minutes and the bell removed for three minutes, and repeated in the same manner. As soon as the discharge from sinuses and wounds becomes less and serous, the duration of the séances is lessened correspondingly.

The mammary gland is to be protected by an aseptic dressing between the séances.

The suction treatment of mastitis fulfils all the demands which can be made upon an ideal treatment. It sucks away the pus and milk, and hyperæmizes effectively. It thereby relieves pain, suppresses infection, dissolves old indurations, and causes their reabsorption. *It leads regularly to the restoration of the mammary gland*, and in this manner is essentially different from the customary surgical treatment, whose appearance and functional results are indeed bad. For it required a long time for a cure, led to pronounced cicatricial contraction of the gland, which damaged its function, disfiguring and exposing it to susceptibility for the development of carcinoma.

The suction method no less excels the old treatment with cataplasms and small incisions, because it produces a more effective form of hyperæmia, limiting, instead of increasing, suppuration, and enabling the thorough removal of the pus. Here, too, the principle which has guided us in all our

[1] Stich, "Zur Behandlung akuter Entzündungen mittels Stauungshyperämie" (*Berliner Klin. Wochenschrift*, 1905, Nos. 49 and 50).

hyperæmizing methods is beautifully realized: *The greatest possible avoiding of mutilation and disfigurement, greatest possible restoration of function with the smallest and least painful procedures.*

It is interesting to note that it seems this method of treatment of mastitis has a precursor in popular medicine. A Russian colleague, who visited our clinic to see the treatment with hyperæmizing agents, told us that in some regions of Southern Russia women afflicted with mastitis, at the very beginning of the disease, place large pots over the glands, in which some kerosene has been ignited, and that they are convinced of the effectiveness of these large cupping appliances.

I finally quote a few examples of puerperal mastitis and their treatment with suction-bells, and commence with two cases in which the procedure caused recession of an incipient mastitis.

81. A servant-girl, twenty-six years old, came March 2, 1905, with the statement that she had given birth June 23, 1904, and had since fed the baby with the left breast. In the night from March 1 to 2 she experienced severe pains in the left breast, so that she was unable to sleep. The trouble increased in the next days, and to this was added headache and fever. We found a pronounced enlargement of the left breast, which was painful throughout. In the lower half was an induration. The skin over it was red.

March 3 suction treatment was instituted; 30 c.c. of milk were evacuated. The pain disappeared, but reappeared again at 4 p.m., after doing housework (cleaning windows) at the order of her employer. For this reason she was admitted to the clinic March 4, where the suction treatment was continued. A large quantity of milk was removed by the additional aid of the ordinary "breast-pump." The pain greatly decreased after this, the gland became smaller, and little was noticed of the infiltration. March 5 the left breast was very soft, nowhere sensitive to pressure, and of the same size as the right one. The suction treatment was continued a few days.

82. February 9, 1905, a patient of the Bonn gynæcologic clinic came under our care. She had given birth nine days ago, and the puerperium so far had remained normal; but the previous evening she began to complain of pain in the left breast. In its lower half was a pronounced infiltration sensitive to pressure. Suction treatment instituted at once removed the trouble in two days. The patient was discharged cured February 11.

The majority of cases we have seen either had already abscesses or suppurated during the treatment.

83. A woman, twenty-three years old, began to suffer immediately after delivery from an acute left-sided mastitis. She was admitted May 9, 1905. The left mammary gland appeared twice as large as the right one, and was very much indurated. Fluctuation could be felt, though not certainly, in the lower inner quadrant. The gland was given a suction treat-

ment. Fluctuation became more perceptible the next day. At that place an incision 1 centimetre long was made, and about ½ litre of pus was evacuated in a stream. After the application of the suction-bell a large quantity of pus mixed with blood was evacuated. The incision became closed repeatedly by blood-coagula and scabs, and required opening by means of a dressing forceps.

May 11 a second abscess was incised. May 17 suction did not produce any more pus. The mammary gland was soft and nowhere sensitive to pressure. The patient was referred to the dispensary for further treatment. May 19 pus accumulated once more under the unhealed incision wound, requiring separation with the dressing forceps. The bell sucked out thin pus. The patient was discharged cured May 28. The mammary gland was soft and free from pain.

84. A servant-girl, twenty-five years old, immediately after delivery became afflicted with a left-sided acute mastitis. She was admitted to the surgical clinic May 3, 1905. The left mammary gland, in its lower half, was intensely swollen, red, painful, and indurated. The girl gave the impression of being seriously ill. Bodily temperature was greatly increased; pulse 120. Suction treatment was applied. Patient felt relieved after that. The general condition improved, and the temperature sank.

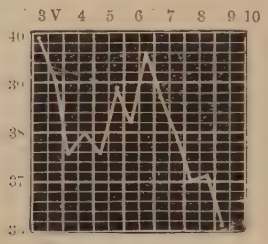

Chart XX.

May 6, however, fever again appeared, and fluctuation could be plainly felt. The abscess was opened by a stab puncture. A large quantity of thick pus was evacuated. In this case, too, the stab opening occasionally became closed, so that it had to be opened with the probe. Patient was discharged cured May 24. The mammary gland was soft everywhere, and at no time sensitive to pressure. The scar of the puncture could hardly be seen.

Chart XX. shows the course of the temperature.

The following case shows that old and neglected cases can yet be successfully treated with the suction-bell:

85. A woman began to suffer from right-sided mastitis a few days after being delivered. Oil cataplasms caused an abscess to open at the inner side of the nipple. Four weeks ago the breast was incised in a hospital, and she was discharged after three weeks without being cured.

March 6, 1905, she applied for treatment at the Bonn polyclinic. The right breast was in the following condition: The breast is arched forward in the outer upper quadrant, where it appears as tough to the feel as a malignant swelling. The breast shows three radiating, poorly granulating incised wounds 8 centimetres long and 3 centimetres wide. The skin around the nipple is thinned; the nipple has almost disappeared. The patient had severe pains and had no appetite.

The disease improved under suction treatment very rapidly. The pains disappeared after the first séance, to return March 20 after exertion. At

that time two of the almost healed incised wounds reopened, and thick pus was evacuated. May 16 all wounds had healed, and the previously stone-hard breast became soft and insensitive to pressure, except at the operation scars.

The excellence of the suction treatment of mastitis is generally recognized, the exceptions being insignificant.

* * * * *

I mentioned in the General Part that several aurists (Sondermann, Spiess and Muck) have lately utilized the suction method with the intention of hyperæmizing and at the same time removing the secretions in diseases of the ear, nose, and its accessory cavities, and they report good results. I myself have no experience with these diseases, as the limited material placed at my disposal for the past two and a half years has been utilized by me to study the effect of congestion hyperæmia by the constrictor. In the preceding edition I still wrote: "It seems as if one might replace bandage-congestion with the more convenient suction apparatus in diseases of the eye. But one would have to work delicately and with great care, owing to the delicacy of the organ. One has a disagreeable sensation when a large cupping-glass is placed over the eye and the air within is rarefied." Meanwhile oculists have developed the technique of suction hyperæmia of the eye, so that there exists no objection to its application to the eye. Detailed investigations on this subject are given by Hoppe.[1] He found that a negative pressure of 20 to 40 millimetres Hg is indicated in diseases of the eye. If this degree is not exceeded, the entire procedure of suction is by no means disagreeable to the treated eye. Hoppe unites bell and rubber ball of the suction appliance by a piece of thick rubber tubing, a branch of which leads to a mercury manometer, which registers the negative pressure in the suction-bell. Such a manometer, which I consider useful because of the delicacy of the eye, is too complicated and unnecessary for other areas.

A similar appliance was recommended at about the same time by Hesse.[2] He too, like Hoppe, works with a suction-glass, whose margins are cut to correspond to the

[1] Hoppe, "Über den Einfluss der Saughyperämie auf das gesunde Auge auf d. Verlauf gewisser Augenkrankheiten" (*Münch. Med. Wochenschrift*, 1906, No. 40).

[2] Hesse, "Die Stauungshyperämie im Dienste d. Augenheilkunde" (*Centralblatt f. Augenheilkunde*, June, 1906).

form of the surroundings of the eye, and which is connected with a manometer. Hesse, like Hoppe, considers 20 to 50 millimetres Hg negative pressure necessary.

According to Hesse's statements, in contradistinction to the cited views of Wessely, the deep as well as the superficial vessels of the eye participate in the dilatation—at least, when the eyelids are open.

Hesse as well as Hoppe had good results with the treatment of eye diseases by means of suction appliances.

BRIEF REVIEW OF MY EXPERIENCE AND THAT OF OTHER PHYSICIANS IN ACUTE SUPPURATION

Up to about one and a half years ago we stood practically alone in our experience with induced hyperæmia in acute suppuration and inflammation. Meanwhile an extraordinarily large literature on this subject has developed. The principal labours are cited in the footnote,[1] in so far as they do not refer to special chapters, in which they have been

[1] 1. Arnsperger, "Erfahrungen mit Bier'scher Stauung bei akuten Eiterungen" (*Münch. Med. Wochenschrift*, 1905, No. 51).

2. v. Brunn, "Über d. Stauungsbehandl. bei akuten Entzündungen nach d. bisherigen Erfahrungen der v. Bruns'schen Klinik" (*Beiträge zur Klin. Chir.*, vol. lxv., p. 845).

3. Danielssen, "Über d. Bedeutung d. Bier'schen Stauungsbehandlung akuter Entzündungen f. d. Chir. Poliklinik u. d. prakt. Arzt." (*Münch. Med. Wochenschrift*, 1905, No. 48).

4. Derlin, "Beitrag z. Behandlung akuter Eiterungen mit Bier'scher Stauungshyperämie" (*Münch. Med. Wochenschrift*, 1905, No. 29).

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20. Lindenstein, "Erfahrungen mit der Bier'schen Stauung" (*Münch. Med. Wochenschrift*, 1906, No. 38).

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22. Rubritius, "Über d. Behandl. akuter Entzündungen mit Stauungshyperämie" (*Beiträge z. Klin. Chir.*, 1906, vol. xlviii., No. 2).

23. Cathcart, "On Bier's Treatment of Acute Inflammation," etc. (*Scottish Medical and Surgical Journal*, April, 1906).

24. Polini, "Stasi alla Bier" (*Gazetta Internazionale di Med.*, 1906, No. 84). This article contains a careful review of the Italian literature.

25. Beer, "The Therapeutic Value of Artificial, Localized Hyperæmia," etc. (*Medical Record*, New York, August 25, 1906).

26. Hoppe, "Die Behandl. v. Unfallschäden und deren Folgen durch den Chirurgen" (*Med. Klinik*, 1906, No. 44).

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28. Engländer, "Eitrige Brustdrüsenentzündung bei einer Stillenden," etc. (*Centralblatt f. Gynäkologie*, 1906, No. 16).

29. Ullmann, "Über Stauungs- und Saugtherapie," etc. (*Berliner Klin. Wochenschrift*, 1906, Nos. 18 and 19).

30. v. Pezold, "Furunkelbehandl. mittels Bier'scher Saugapparate" (*Deutsche Militärärztl. Zeitschr.*, 1906, No. 6).

31. Breuer, "The Bier Treatment by Hyperæmia" (*Medical Record*, February 24, 1906).

32. Lexer, "Zur Behandl. akuter Entzündungen mit Stauungshyperämie" (*Münch. Med. Wochenschrift*, 1906, No. 14).

33. Bestelmeyer, "Erfahrungen über die Behandlung akut entzündl. Prozesse mit Stauungshyperämie nach Bier" (*Münch. Med. Wochenschrift*, 1906, No. 14).

34. Manninger, "Die Heilung lokaler Infektionen mittels Hyperämie" (*Würzburger Abhandlungen*, vol. vi., No. 6, 1906).

35. Thorbecke, "Die Behandlung d. puerperalen Mastitis mit Stauungshyperämie" (*Med. Klinik*, 1906, Nos. 37 and 38).

36. Lämmerhirt, "Die Behandl. mit Stauungshyperämie nach Bier in d. Hand d. prakt. Arztes" (*Med. Klinik*, 1906, No. 15).

37. König, "Über Stauungsbehandl. der Epididymitis gonorrhoica" (*Med. Klinik*, 1906, No. 24).

38. Böhme, "Kurzer Bericht über durch Bier'sche Stauung mit Saugglocken bei Bubonen, etc., erzielte Erfolge" (*Centralblatt f. d. Krankheiten d. Harn- u. Sexualorgane*, 1906, vol. xvii., No. 7).

39. Bum and Ullmann at the joint Congress of the Deutsche Balneol. Ges., etc. (*Wiener Klin. Wochenschrift*, 1906, Nos. 14, 15, and 16).

of the Thirty-fifth Congress of the German Society of Surgery, at which numerous speakers have reported their experiences.

On the whole, these physicians have obtained similar results to ourselves. A few expressed themselves unfavourably on the effect of congestion hyperæmia. Among them especially to be mentioned is Lexer, whose objections I have already discussed. The phlegmons of the tendon sheaths are the conditions which are decisive for the value of the method ; and almost all reports agree that a large percentage of tendons whose sheaths had suppurated have been kept alive by the congestion hyperæmia, and, what is more important, have been preserved functionally. Several physicians are considering whether they would not have obtained equally good, if not better, results in suppurative phlegmon of the tendon sheaths with the old method. I ask them this question : Have you ever seen on any occasion that a tendon bathed in pus with a phlegmon which has existed for days has remained alive and capable of function ? In progressed phlegmons I have never seen it, in the incipient ones occasionally, especially when those infected were physicians who came early for operation, and who energetically practised exercises afterwards in order to mobilize the adherent tendon.

Several colleagues have asked me whether it was not the omission of the tampon rather than the hyperæmia which has saved the threatened tendon. A wide experience enables me to answer this in the negative. Earlier I have practised for some time the treatment with a number of small incisions instead of the large one exposing the entire infected tendon sheath, and supplemented them by a few made at the sides of the fingers. I did not make use of a tampon, but occasionally inserted a small gauze strip, and ordered daily prolonged hand-baths. But in the really developed phlegmons, in which congestion hyperæmia still preserves over one-half of the tendons, they all became necrotic.

The same thing happens when the phlegmons, as is customary with laymen, are treated with heat-giving agents, to

40. Laccetti "Duo Casi di Flemmone," etc. (*Gazetta Internazionale di Med.*, 1906, No. 88).

41. Stiassny, "Ein Beitrag zur Prophylaxe und Therapie d. Mastitis" (*Gynäkologische Rundschau*, 1907).

which either small incisions are added or which open spontaneously. They "heal" occasionally just as well if not better than is accomplished by the surgeon with long incisions and the entire antiphlogistic apparatus; but later on the necrosed tendons appear through the fistulæ as "worms." The hyperæmia produced by heat, as I have repeatedly shown, is not the right form, especially for acute inflammation, and cannot at all be compared with the natural congestion hyperæmia.

Habs reports four cases of grave suppuration of the knee-joint (three of which were traumatic). They all healed, with full function, by congestion hyperæmia. As regards their value as proof, they can be placed alongside the cases of suppuration of large joints described by me above. Others, too, have reported good results in suppuration of joints.

The reports on the results in acute osteomyelitis varied, just as with our cases. It is evident that, in addition to the virulence of the causative bacteria, the main thing in this disease is early applied treatment.

Other physicians report results similar to ours in the treatment of acute suppuration with cupping-glasses.

My observation that hyperæmia relieves the pain due to inflammation, and does not produce it, as has been asserted, has been generally confirmed; as also the fact that properly applied congestion hyperæmia means improvement, and not diminution, of nutrition.

I believe, therefore, that I have by a simple, practical experiment proved the old and undecided question, as to whether inflammation is a useful or noxious process;[1] and

[1] Since the spreading of the recognition of the efficacy of congestion hyperæmia in inflammation, a number of smart people now come to think that they have known long ago that inflammation is something useful, though they remained silent when I was a preacher in the desert. I have received letters from all sorts of physicians (allopaths, homœopaths, "natural" physicians) bearing that meaning. As if this were anything new! Just as with fever, they have quarrelled also in this respect about inflammation. It is quite natural that far-sighted physicians and laymen have given their entire attention to so elementary a natural process as inflammation, and have considered it from diverse standpoints. The question, therefore, is very old. What difference of principle is there when the Nature-man sees the evil spirit which has taken possession of the body driven out by the inflammation and fever, or we the bacteria, toxins, and other noxious things? Enemy and defender have changed, depending on contemporaneous views, and have been mistaken for each other. But it is much easier to establish a polemic question than to solve it.

this, above all, is the main thing. I therefore deem it relatively unimportant when the question is propounded and extensively discussed, whether this or that inflammatory disease would be better treated with congestion hyperæmia or with the old method. This is not at all the kernel of the matter, for the main thing is whether the principle is correct.

It is quite evident that in the large domain to which hyperæmizing therapy is applicable brilliant results cannot at once be expected everywhere, especially since, until recently, I and my pupils have stood alone in this respect. The individual man and the individual school are soon exhausted, and remain stationary. It requires the experience and collaboration of many to guarantee progress. This is to be expected from an improvement in the establishment of indications and technique. I do not even deem it impossible to secure increased hyperæmia by simpler and more usable agents than the bandage-constrictor and the suction apparatus.

Just now, without doubt, I consider them to be the best agents. But to control them is not at all simple. Since my utilization of the constricting bandage I have seen at least twenty times that excellent physicians, whose patients have come to me for treatment, had applied it in the worst possible manner. We simply repeat the old experience, that apparently simple things are learned with difficulty. For this we have sufficient examples. One need only think of antisepsis. Many have not learned throughout their lives to wash their hands correctly. Many failures will be understood if we consider how important innovations meet with resistance from many people prejudiced by school opinions, and that these methods are very inconvenient to them and unsympathetic.

Two preliminary conditions must be fulfilled for a successful treatment of acute inflammatory disease. First, treatment must be instituted *very early*, I have emphasized in different places in this book. This demand *must* be realizable. We have educated the public to permit operation in acute appendicitis within the first twenty-four hours ; should it not be possible for the combined effort of the physicians to educate the public to report themselves with acute inflammation still earlier, in order not to be operated upon ?

Next, one must personally take an interest in the cases (for there can be no pattern-method with our treatment), or entrust them to an assistant who is possessed of enthusiasm for the matter, experience, and conscience. (It has become the fashion to entrust the "septic cases" to the youngest and most inexperienced assistant.) Otherwise nothing will be accomplished save the bringing into ill-repute of a method in itself very good.

The hyperæmia treatment has had a remarkable fate. At first the active hyperæmia gained recognition, but the passive form was killed with silence. It has been since the congress of surgeons preceding the last, where I demonstrated the method of congestion hyperæmia to a larger number of colleagues, that it has been employed, though I then announced nothing new in principle, but what I had said long ago. But now it is taken up with great zeal. Now there is danger that the other forms of hyperæmia will be neglected. This danger is great, because many of our bacteriologically trained physicians find only infectious diseases "interesting." I do not desire to see a chapter torn from my general system of hyperæmia therapy and cultivated one-sidedly. The hyperæmia is no specialistic, but a generally physiological remedy, supporting self-healing. We should learn to direct the healing blood according to our wishes—as need be, to check it now, or to hasten it through, in order to purify and irrigate it.

TREATMENT OF NON-INFECTIOUS DISEASES WITH HYPERÆMIA

In the treatment of non-infectious diseases, the active hyperæmia as produced by hot air stands in the foreground, though many of them can be treated equally well, if not better, with congestion hyperæmia.

I can be much briefer here than in dealing with the treatment of local infectious diseases, for hot-air treatment is generally recognized, scarcely requiring any special recommendation, for it now belongs to the fashionable remedies. There are few diseases in which it has not at least been tried. Its technique, furthermore, is extraordinarily simple, so that, with the exception of cases with sensory paralysis,

with a certain amount of attention no harm can be done. The technique of congestion hyperæmia in non-infectious diseases, which can be frequently made good use of, is here much simpler, and, what is the main thing, less dangerous. In the treatment of infectious diseases, on the other hand, things are entirely different. A decennium has passed during which no attention has been paid to congestion hyperæmia; it belonged to the methods of treatment which, in the eyes of my colleagues, "self-evidently" and "naturally" were good for nothing. The trials on their part—if tried it was—"naturally" gave results correspondingly, and the successes which I reported were fantasied or even faked. For this reason I have practically stood alone with my pupils in the theoretic and practical perfecting of this method. Though of late quite a change was noticeable, I thought it necessary to thoroughly discuss the details of congestion hyperæmia, and to substantiate my assertions with exact clinical histories. This was all the more important because the technique of congestion hyperæmia is not as simple and as systematic as the hot-air treatment, and an ignorant and unskilful physician could not only fail to achieve anything, but even do mischief.

As all this does not need to be considered for the diseases which I will proceed to describe, I believe the narration of clinical histories to be unnecessary, and will limit myself to the report of facts, especially since I have given much space in the General Part to active hyperæmia. This, too, was necessary, because wrong conceptions of the effect of this remedy had been formed, as well as prejudices difficult to extinguish, so that for a long time I stood alone with its theoretic explanation.

TREATMENT OF CHRONIC STIFFENING, ESPECIALLY OF THE JOINTS.

The results obtained with the treatment by hyperæmia, active as well as passive, in all possible forms of stiff joints were convincing. It matters not whether these were due to chronic articular rheumatism, arthritis deformans, trauma, or acute, especially gonorrhæic inflammation. For these affections active hyperæmia produced by hot air is

principally indicated, but while discussing the diverse diseases we will see that often also congestion hyperæmia and our suction apparatus have frequently been used with great success.[1]

Chronic Articular Rheumatism.

In spite of the modest successes, the favourable effect of hot air on chronic articular rheumatism is so generally recognized that it is superfluous to cite proofs for it from the large literature which has accumulated.

The hot-air apparatus is applied for the individual stiff joints one hour daily. If many joints are affected, they naturally cannot all be locally treated with heat, for that would prove too exhausting for the patient. It is advisable to select the worst joints and to treat them. It has been observed also by others—as has been mentioned in the General Part—that the untreated joints improve at the same time. I have already given an explanation for this phenomenon.

The number of joints afflicted with rheumatism that we may daily treat with hot air depends on the strength of the patient. Strong patients with rheumatism of all joints of the four extremities can, for example, be treated in this manner: In the morning each leg is placed in a hot-air box which reaches to the middle of the thigh, each for half an hour; and in the afternoon each arm is treated likewise in a box extending to the shoulder. One should wait and see whether the non-treated hip, shoulder, and vertebral column joints do not improve by themselves. If this is not the case, one should alternate, treating one day the above-named joints, and the next the hip and shoulder joints. For the diseased spinal column one of the described hot-air douches is more practicable.

Treatment of two hours' duration is highly fatiguing for the rheumatic, and only strong individuals can stand this for some time. I have seen several patients who have been greatly reduced physically and made nervous by such

[1] Langemak ("Über Jute-Fliess-Verbände," *Münch. Med. Wochenschrift*, 1904, No. 43) recommends for the hyperæmization of stiff joints "jute-fliess" dressings. These were highly praised by Gocht at the Congress of the Deutsche Ges. f. Orthopäd. Chir., 1904.

energetic treatment. For this reason one had best limit oneself to a few joints, and then alternate, if one does not prefer to combine the hot-air treatment with other less taxing hyperæmizing methods. I have repeatedly called attention to this.

If but few joints are attacked, or, as happens most frequently, one or more are so greatly affected that they cause trouble, while the others, though not well yet, are free from annoyance, I usually treat one joint one hour in the hot-air box ; but here, too, I am guided by the general condition of the patient. If the patient is weak, I am satisfied with a séance of one half-hour.

After the hot-air treatment has been given several weeks or months steadily, I make a pause of one to four weeks. During this time the affected joints are treated with Priessnitz compresses, worn during the night, if I do not make use of other more intensely hyperæmizing agents.

I caution the physicians who treat chronic rheumatism not to forget the congestion hyperæmia, which I have used as long as hot air for this disease. It often gives better results than the hot air in acute exacerbations, to which the chronic rheumatic is occasionally exposed, especially in the smaller joints, such as elbow, wrist, and fingers. In the knee-joint I have seen but little success with congestion hyperæmia, principally because it is difficult in rheumatic cases to produce hyperæmia in that joint. On the other hand, the results in the joints of the foot are better.

The constrictor is worn twelve to twenty-two hours daily. The œdema is removed by massage and elevated posture once or, better still, twice daily. There is no need for a scientific method of massage, but a mere stroking away of the œdema. I consider this necessary, because the congestion hyperæmia dissolves the stiffening, but does not reabsorb. As regards the hand and forearm, the œdema can be advantageously removed by the mercury massage after Hofmeister.[1] The patient immerses hand and forearm with slow rhythm deep into an iron cylinder filled with mercury. The mercury produces a gentle but firm pressure on the extremity, and rapidly removes the œdema. The method

[1] Hofmeister, " Ein neues Massageverfahren " (*Beiträge zur Klin. Chir.*, vol. xxxvi., No. 2, 1902).

is indeed good, and is, it seems to me, made use of less often than it deserves. I can confirm Hofmeister's favourable results. Besides, I do not hesitate to count even this remedy among the hyperæmizing ones. For the sudden removal of the œdema the vessels are freed from pressure and dilated, and the strong pressure of the mercury during each immersion makes the peripheral part of the extremity bloodless. This bloodlessness is at once followed by a reactive hyperæmia.

The congestion hyperæmia which is used for chronic rheumatism must be so intense that a pronounced œdema of the extremities is produced; otherwise it will do little good.

Compared with the hot-air treatment, the congestion hyperæmia has this advantage, that it makes no demand on the strength of the patient. Its effect does not at once become striking in chronic rheumatism, but can be observed after weeks. It is therefore not so seductive as the hot-air treatment, of which the patients often after the first séance state that the extremity is more supple and less painful. But it cannot be mere accident that my best *prolonged results* in chronic rheumatism have been obtained with congestion hyperæmia which has been administered systematically for years—of course with interspersed pauses.

In intense chronic rheumatism of numerous joints I usually proceed in this manner: Knee, hip, and shoulder joints are treated with hot air; elbow, wrist, and finger joints, frequently also ankle-joints, with congestion hyperæmia, and massaging of the œdema repeated twice every day. The use of the joints subjected to hyperæmia is thereby not at all restricted.

If one desires to be convinced of the improvement of function of the joints treated with congestion hyperæmia, the œdema, naturally, must first be got rid of; for œdematous extremities are in themselves stiff, and not freely movable.

Our suction apparatus, too, can occasionally be made good use of in chronic articular rheumatism, especially when we have to deal with pronounced stiffness. However, forcible movements should be avoided even in the mildly effective suction apparatus, for rheumatic joints, as I have frequently observed, are rendered worse by too taxing attempts at mobilization.

I myself have never undertaken forcible extension and flexion under anæsthesia, but have seen several cases on whom this has been practised by others, and which were followed by the worst consequences. I therefore lay special stress on this, that the mobilization of chronic rheumatic joints must be undertaken gradually and gently. I also earnestly protest against the placing at rest of such joints. This is usually followed by a turn for the worse, and lessened functioning. I take care that the rheumatic does not cease to use his extremities, especially walking, and even, if he is very stiff, I try to get him on to his legs by first ordering the use of a walking-chair, and crutches later on.

Contrary to these observations, Neumann[1] has recommended that all joints disposed to ankylosis, including those afflicted with arthritis deformans, be forcibly mobilized under anæsthesia, and to immediately subject them to a hyperæmizing treatment. I believe I am not mistaken in assuming that Neumann here counts as arthritis deformans cases which I am in the habit of counting as chronic articular rheumatism, so that we both have in mind the same form of stiffness. Neumann applies hyperæmia to the forcibly mobilized joints, while the patient is still under the anæsthetic, by means of a fango-compress, then by an alcohol dressing, which is changed every few hours, and in the afternoon of the first day the painful and swollen joints are treated in the hot-air apparatus. In addition to this treatment, passive motions are undertaken as early as possible. Neumann reports very good results which he has obtained with this method. I myself have no experience with it.

I must add a few brief remarks on the *results* of hyperæmia treatment in chronic articular rheumatism.

I regret to be unable to present statistics. I must content myself with presenting the general impression which I have gained from this treatment. I have a wide experience with this disease, because, I may say, I have had the misfortune to acquire the reputation of a specialist for the treatment of chronic articular rheumatism, and have therefore been

[1] Neumann, "Das 'brisement forcé' und seine Nachbehandlung mit Thermotherapie" (*Ärztl. Mitteilungen aus und für Baden*, vol. lviii., No. 2, 1904).

sought out by private patients, who had worn out all sorts of methods of treatment without success. I must confess that with our treatment, too, the results were very moderate. I have really seen but three cases of grave chronic rheumatism which have been approximately cured. In the first edition of this book I reported that I had experienced but one real cure. Exact information which I sought having now been obtained, I must retract this assertion also. The patient considers herself completely cured. According to the report of his physician, we have not a complete cure in the anatomical sense, but a complete removal of all troublesome symptoms. The lady under consideration, who suffered from intense chronic rheumatism, has regained the use of her limbs by the treatment with hyperæmia, which had been administered for years. She can, for example, climb mountains without trouble, while before she could scarcely drag herself along with sticks. I have two similar reports on patients who have taken our treatment for years. It is noteworthy that these three patients were seriously afflicted, were young (twenty to thirty years), and that success was principally obtained from congestion hyperæmia.

In spite of the total miserable results, treatment with hyperæmia appears to rank above all others as the best for chronic articular rheumatism, and considerable improvement of the disease, especially in regard to the subjective symptoms, is obtained almost invariably. I have frequently seen that the patients who tired of the treatment and interrupted it were later compelled to return, because they had become convinced that other methods of treatment offered much less hope of relief.

Arthritis Deformans.

I do not intend to discuss the difference between chronic rheumatism and arthritis deformans. I must say that in the majority of cases I do not succeed in sharply differentiating these diseases. I have made a determined endeavour to instruct myself by the study of the literature on these joint diseases, but have not become any wiser. An incredible chaos exists, and in many cases it seems to me a matter of taste as to what is understood as arthritis deformans and what as chronic articular rheumatism. I see but

infrequently cases of undoubted arthritis deformans. I believe I have treated it with similar success as chronic articular rheumatism by means of hyperæmia treatment.

Others assert that arthritis deformans is less suitable for treatment by hot air and congestion hyperæmia than chronic rheumatism (Habs, Bum, Laqueur, v. Leyden, and Lazarus, in their cited contributions).

Traumatically Stiffened Joints.

Better results than with the above-named diseases are obtained in joints stiffened by trauma. These, too, we have treated principally with hot air. The technique is the same as I have described for chronic rheumatism of the joints, with the difference that, because we have usually but one joint and strong patients, séances of one hour can be begun with. In traumatically stiffened joints the rapid subjective improvement is very striking. The patients state that painfulness soon disappears, and that mobility is greatly increased.

The congestion bandage can be utilized to advantage also in the traumatically stiffened joint. After I had earlier obtained favourable results with suction apparatus, my former assistant, Staff-Surgeon Dr. Blecher,[1] introduced the same treatment for traumatic stiffening of joints which I had practised for the rheumatic. I refer, as regards the congestion hyperæmia treatment of these affections, to the technique recommended for chronic articular rheumatism.

Sudeck[2] has confirmed the observations made by Blecher. Sudeck is of the opinion that stiff joints after inflammation and injury are due to bone atrophy demonstrated by him as associated with them, and that the congestion hyperæmia acts by increasing the growth of new bone. This view is very one-sided; for while it is true that in those diseases the bones become atrophic, it is not they alone which suffer, for the soft parts, too, become atrophic. I have mentioned repeatedly that the atrophy of the soft parts improves under treatment by hyperæmia. It is therefore arbitrary to place

[1] Blecher, "Ueber den Einfluss der künstlichen Blutstauung auf Gelenksteifigkeiten nach Trauma und längerer Immobilisation" (*Deutsche Zeitschr. f. Chirurgie*, vol. lx.).

[2] *Loc. cit.*

the atrophy of the bones in the foreground, with the improvement of which the stiffness becomes better. For I have observed stiff joints of grave form improve under treatment by hyperæmia, radiographs of which showed hypertrophy and not atrophy of the bone; also such which evidently concerned only the soft parts, as in tendon and skin scars, caused by panaris. Furthermore, I have observed, as already mentioned, that nodular thickening of the tendons due to gonorrhœal inflammation disappears under treatment with hyperæmia. I therefore, now as before, lay great stress on the solving effect of hyperæmia, which, as already mentioned, we have been able to repeatedly observe. That, in addition, other factors are active I have never doubted.

I have often asserted my belief that serous infiltration and swelling of shrunk soft parts play an important part, and, above all, in the relief of pain associated with hyperæmia. Otherwise it is difficult to understand how stiff joints, after having been rendered hyperæmic for one hour, become more mobile. I do not doubt that the purely passive nutrition of the bone is partly responsible for this. But of all the things which are under consideration this is the least proven. That atrophy rapidly disappears after the removal of the cause of the disease is no more astonishing than that it develops with an incredible rapidity. But we know the reason neither for one nor the other.

The orthopædic suction apparatus described in the General Part are most effective in traumatic stiffening of joints, especially the technically best-constructed hand appliance for stiffening of the fingers and wrist. The apparatus can be applied energetically in these diseases, and we have had excellent success with it. For the technique I refer to the description given in the General Part.

Our treatment is highly effective, not only in stiffening, but in all possible sequelæ to injuries of joints. I name here the frequent variable changes and troubles which remain after injury of the joints, especially the knee-joint—*e.g.*, gonitis crepitans, which is very common. The latter I have not cured, but so improved that the symptoms have completely disappeared, or at least greatly lessened. I treat gonitis crepitans in the first place with hot air, and then with the hyperæmizing suction apparatus. Treatment

with the congestion bandage has yielded no special success, and generally the knee-joint, for reasons not thoroughly understood by me, is the least suited for treatment with congestion hyperæmia.

I must make brief mention of the frequent symptoms, especially of the knee-joint, which remain after injuries, and which offer no objective evidence save that of a slight atrophy. A labourer seeking accident insurance in such cases is usually refused. With people who have no interest in feigning or exaggerating disease, in order to demand aid, one falls back upon the fictitious diagnosis of neurosis, meniscus injury, or the like. Of late I have frequently seen such cases in army officers, agriculturists, sportsmen, and I dare not pass an opinion as to what really is the matter. Fortunately, these cases can be successfully treated without a diagnosis by hyperæmizing agents, especially hot air, and with gradually increased use of the affected joint. I lay great stress on exercise, because I am of opinion that the disease of these people, who run from one physician to another, is frequently kept up by the treatment. Everywhere they are advised to rest in bed, and treated by immobilizing bandages, compression, elastic stockings, and occasionally even operations. These measures increase the weakness, robbing the patients of their confidence in their extremities.

Hyperæmia treatment can be utilized with the same success as in stiffening of the joints, also on such of the soft parts, provided we do not have to deal with old rigid scars.

Gonorrhœic Stiffening of Joints.

I regret to say that to this day can be seen the gravest stiffening of joints after gonorrhœa. This is principally due to the fact that physicians do not employ in recent cases the hyperæmic treatment recommended by me thirteen years ago, especially the congestion hyperæmia, and also to the fact that this method has been entirely ignored in textbooks and treatises, even by authors who enjoy the reputation of special knowledge of this disease. Immobilization of the joints has been recommended, the surest means to produce stiffening. I hope that a reform will take

place when the physicians have once learned to use congestion hyperæmia in acute cases, and, as I have recommended, to immobilize in cases either not at all, or at least only temporarily, and instead to early undertake motions. In gonorrhœic stiffenings, as in traumatic ones, we obtain better results than in those caused by chronic rheumatism and arthritis deformans. All forms of hyperæmia can be utilized, especially the active, produced by hot air, which, as already mentioned, is excelled by congestion hyperæmia in acute and subacute cases.

Treatment of Scoliosis.

Here must be cited the treatment of scoliosis with hot air introduced by Klapp. For, after all, there is no principal difference between a stiffened joint and the sequelæ concerning its bone and soft parts and scoliosis. In the latter, too, we demand that the treatment should first of all remove the stiffness. A rich experience has shown us that the hot-air treatment of scoliosis accomplishes this in a prominent measure. The attending physicians could demonstrate objectively a greater mobility of the scoliosis, and children (without receiving any suggestion) stated that they felt more supple after the hot-air treatment. I believe that in scoliosis this treatment does not only equal that by massage, but even excels it. To this must be added that, owing to the great number of patients in the clinics, it is not possible to thoroughly practise massage in each individual case. In the surgical clinic at Bonn more than sixty patients with scoliosis are treated daily. Although we have, in addition to the supervising assistants, two gymnastic instructors (female) and a masseuse, it is impossible to give everyone a thorough massage treatment, for their services are also needed for the other orthopædic patients. Of course, the gymnastic exercises can be very well practised on a large scale.

Similar conditions no doubt prevail also in other clinics, where frequently a smaller personnel of physicians and gymnasts are attached. Ostensibly everything is massaged, but it cannot possibly be done thoroughly. Under these circumstances it seems to me important to have a substitute which enables us to treat at one and the same time a larger number of scoliotics with little attendance.

As a comparatively large part of the body is exposed to the heat, the séance lasts only twenty minutes. A longer application would prove too severe. Immediately after the séance the exercises are commenced, which are practised in a large, well-ventilated room, the patients dressed in light and cheap athletic dresses.

Besides, the hot-air treatment is to act only as an aid to the gymnastic exercises.

TREATMENT OF RECENT SUBCUTANEOUS INJURIES

The treatment of recent injuries by active hyperæmia—the only form that is to be specially considered in such cases—is best described in connection with some bone fractures (radius and malleoli).

Recent fracture of the radius is first of all reduced, if need be, under narcosis or Schleich's infiltration anæsthesia.[1] If the immediately made Röntgen picture shows that the fragments are not properly adjusted, reduction is continued until the correct position has been obtained. According to F. Petersen's method, the radial fracture is not put in splints, but is simply placed in a mitella. The properly adjusted fragments as a rule become so thoroughly interlocked that a fixed bandage is not necessary. On the very first day hand and forearm are placed in a hot-air box for one hour, and this procedure is repeated daily. This treatment is extraordinarily effective. It very soon removes the pains, and permits the patient to undertake movements in the wrist-joint and in the finger-joints without difficulty.

Fracture of the malleoli, too, is controlled by the radiograph, either in narcosis or in spinal anæsthesia, until the fragments are in proper apposition. An ambulatory plaster-of-Paris bandage after Krause is applied. After this has been applied ten days it is cut into an anterior and posterior splint, and foot and leg are given daily hot-air treatments. After ten days the firmness of the fracture has

[1] Fracture of the radius can be painlessly reduced under Schleich's infiltration anæsthesia if the immediate vicinity of the bone and the periosteum are well infiltrated.

been established so far that a displacement of the fragments need not be feared. In case the patient should experience trouble in the padded split-splints of our apparatus (which is rarely the case), all conveniences for the injured extremity are introduced into the hot-air box. During the treatment the patient moves the ankle actively; the pain-relieving procedure enables this. After each séance the plaster-of-Paris half-splints are reapplied and bandaged together.

In a similar manner, injuries of the soft parts, which lead to large effusions of blood, are treated in the hot-air box with excellent success; I name first of all recent distortions of the joints.

The hot air in all these injuries acts principally by solution and rapid resorption of the tissue particles, especially the blood-effusions, which, as I have shown in the General Part, are obnoxious in fracture of the epiphyses and in injuries of soft parts. In my opinion, the hot air is here a remedy equal, if not far superior, to massage. The former has, furthermore, the advantage that it is much more pleasant and less fatiguing for the patient, and technically easier of execution than the latter. I therefore warmly recommend the hot-air treatment for such affections.

I have also successfully treated blood-effusions into soft parts with prolonged congestion hyperæmia in connection with massage. The congestion hyperæmia dissolves the effusion, and the massage causes its resorption. But the hot-air treatment appears to me to be better because it is much simpler.

Of late Wessel[1] has recommended congestion hyperæmia for all sorts of recent subcutaneous injuries, judging from an extensive experience. Wessel mentions forcibly the rapid disappearance of the traumatic pain, which we can confirm. He furthermore observed that all sorts of effusion of blood, especially those into joints, were very rapidly resorbed, that neither stiffening nor atrophy of muscles and bones developed after the application of congestion hyperæmia. He believes, therefore, that this method is the best remedy for injuries, inclusive of recent fractures, of which he has treated a large number with excellent success.

[1] Wessel, "Om den Bier'ske Stasehyperaemibehandling og dens Anvendelse saerlig ved traumatiske Lidelser" (*Hospitalstidende*, 1906).

Wessel recommends in large blood-effusions that we should not at once institute congestion hyperæmia, in order not to increase the hæmorrhage, but to first apply compression for a few days.

Momburg and Deutschländer used congestion hyperæmia for recent bone fractures before Wessel.

Momburg[1] has treated with it a large number of fractures, and periostitis of the metatarsi (so-called foot swelling of soldiers). He shortened considerably the duration of treatment with this remedy. Recurrences, which were very common with the old treatment, occurred but rarely.

Deutschländer[2] reports a number of recent fractures, in part produced by operation for orthopædic purposes, which he has treated with congestion hyperæmia. He, too, found that the remedy considerably shortens the time required for the cure of the fracture, accelerates the callus formation, and prevents stiffening of joints.

These favourable observations make further experiments with congestion hyperæmia in recent injuries desirable. I myself have no experience as to the efficiency of this agent in recent fractures, but an extensive one in other recent injuries. In the latter I could not convince myself that the congestion hyperæmia was superior to the more easily applied hot air.

HYPERÆMIA AS A RESORPTIVE AGENT

In the majority of cases it is difficult to say which property of hyperæmia produces a cure or improvement. Most frequently the diverse influences ascribed to it in the General Part may be associated. In the following diseases, however, the increase of resorption no doubt plays the main rôle. According to the statements in the General Part it is evident that for this purpose of resorption the active hyperæmia is the one under consideration.

[1] Momburg, "Über Stauungshyperämie bei d. Behandlung d. Fussgeschwulst. Freie Vereinigung d. Chirurgen Berlins, 144th Session, June 9, 1905 (*Centralblatt f. Chir.*, 1905, No. 6, p. 152; and *Deutsche Militärärztl. Zeitschr.*, 1904, No. 1).

[2] Deutschländer, "Über d. Anwendung d. Stauungshyperämie bei orthop. Operationen" (*Zeitschr. f. Ärztl. Fortbildung*, 1906, No. 9), and "Die Behandlung d. Knochenbrüche mit Stauungshyperämie" (*Zentralblatt f. Chir.*, 1906, No. 12).

Treatment of Œdema.

In addition to stiffening of the joints, œdema of variable origin was the first for which I have successfully employed hot air. I made the observation that the œdematous swelling artificially produced by congestion hyperæmia rapidly disappeared when hot-air treatment was given at the same time. Above all, I utilized the latter for the removal of the œdema, which regularly appears after recently healed fracture. In such cases the remedy, as I can affirm from an extensive experience, is very effective, more effective than massage, cold-water treatment, compresses, and orthopædic remedies. It furthermore excellently removes the subjective symptoms remaining after fractures, the painfulness and stiffness of the joints, the heaviness and weakness of the extremities. I therefore warmly recommend the hot-air treatment for these affections. The technique is much as usual.

Treatment of Effusion of Joints.

Hot-air treatment has proved itself valuable for the resorption of effusion of joints. Klapp[1] and Schaffer[2] have reported the experience obtained in sixty cases at the clinic in Greifswald. Since then a whole series of articular effusions have been treated by us in the same manner with satisfactory results. Wiedmann[3] reports thirty cases treated by Martin in Cologne. Hot-air treatment produced complete cure in 80 per cent. One does not always succeed in causing the disappearance of the joint effusion or in preventing its return. But I consider this remedy one of the best we possess. Its great advantage is that the diseased joint is not fixed, and that the patient is allowed to make motions with it. We have even treated several cases of chronic hydrops of the knee-joint in the outdoor department. The avoidance of fixation of the joints offers an advantage in so far as we frequently observe that

[1] Klapp, "Die Behandlung von Gelenkergüssen mit heisser Luft" (*Münch. Med. Wochenschrift*, 1900).

[2] Schaffer, same title. Inaug. Diss., Greifswald, 1902.

[3] Wiedmann, "Ein Beitrag zur Lehre von d. Behandlung d. traum. Kniegelenksergusses." Inaug. Diss., Bonn, 1904.

effusions which have disappeared from fixed joints at once reappeared when the patient was permitted to make motions or to get up.

Bloody effusions of joints can be treated with hot air with equally good results as watery effusions. We see here, too, as in most cases in which hyperæmia treatment is effective, that the rapid disappearance of the pain and symptoms is the most prominent and best sign.

For the joint effusions which have been produced by acute infection induced hyperæmia is more suited. Under it the most tense effusion disappears, often in a few days.

Treatment of Elephantiasis.

I have employed the hot-air treatment in elephantiasis with varying success. In the first edition I reported the following case which ran a favourable course :

86. A woman, aged twenty-eight, noticed eighteen years ago that a swelling appeared on the external malleolus of the left foot, which gradually became enlarged, and spread after several deliveries. She was admitted July 3, 1900, with an enormous elephantiasis of the entire left extremity and incipient elephantiasis of the right leg. The left extremity was treated daily for one hour from July 4 to July 28 with a hot-air apparatus which took in the entire limb. The following measurements will give an idea of how thick the limb was, and how effective the hot-air treatment proved to be.

The circumference of the limb was :

	July 3. Centimetres.	July 28. Centimetres.	Decrease. Centimetres.
Below inguinal bend ..	67·5 ..	56·0 ..	11·5
Middle of thigh ..	67·0 ..	60·0 ..	7·0
Above patella ..	67·5 ..	51·0 ..	16·5
Below patella	53·0 ..	42·0 ..	11·0
Middle of leg	49·5 ..	42·0 ..	7·5
Malleoli	34·0 ..	29·5 ..	4·5
Lisfranc's joint ..	28·5 ..	25·5 ..	3·0

During the treatment the woman lost 9½ pounds. The limb, as compared with its appearance before treatment, could hardly be recognized. The patient was given a hot-air apparatus for use at home. Whether she has used it, and with what success, is not known.

I will, however, not deny that since then two other cases of elephantiasis have been treated, but only temporarily improved by hot-air therapy. As long as the patients remained in the recumbent posture, or moved about but little, the success was very evident, but as soon as they exacted greater efforts from their extremities the swelling

reappeared in the old manner. I have not experience enough to pass a final opinion on the value of the remedy in elephantiasis.

In addition I have employed active hyperæmia in diverse diseases where resorption of œdema and exudate appeared desirable. I especially make use of it to remove the œdema and infiltrations of the skin in varices and ulcers of the leg. This will be discussed in one of the subsequent chapters.

TREATMENT OF KELOIDS

At the instigation of my colleague Thomas in Cologne, who informed me that he has had excellent results with congestion hyperæmia in keloids, we have repeatedly applied this remedy with success in keloids. As in our cases, the affected places were at the neck and trunk. Suction appliances were resorted to. The following case will serve as an example :

87. A woman, forty-four years old, appeared at the surgical clinic in June, 1906, and stated that she had contracted, June 24, 1905—a year ago —extensive burns after an explosion of an alcohol burner, on her face, neck, chest, and arms.

At the right side of the neck was a keloid 14 centimetres long, fiery red, with pronounced elevation, and similar ones, varying in size from 4 to 5 centimetres breadth to 13 centimetres length, on the outer side of the right mammary gland ; multiple smaller keloids of the same character on the chest and back. The largest keloid was found at the inner side of the right upper arm, with diameters of 14 : 11 centimetres. All keloids were painful, and the woman neither day nor night obtained rest because of the itching, burning, and pains, and for this reason had become reduced in strength.

All keloids were subjected to suction treatment. It was not very easy to find suitable glasses for the multiple keloids. When the glasses stuck the woman appeared studded with cupping-glasses.

The pains diminished after the first few séances, itching and burning ceased, and she again got rest. The keloids gradually paled and lost their prominence.

January 15, 1907—that is to say, half a year after beginning of treatment—the keloids presented an entirely different picture. They were pale, soft, and flattened. The woman is permanently free from her troubles.

A similar case of keloid has been treated by Wessel.[1] At an incised wound on the finger a keloid of the size of a

[1] Wessel, " Om den Bier'ske Stasehyperaemibehandling og dens Anvendelse saerlig traumatiske Lidelser " (*Hospitalstidende*, 1906).

bean developed. It was reddish-brown, and so painful that the patient could not sleep. Wessel treated the keloid with the congestion bandage. The pains disappeared after two days, and the entire keloid after twenty-two days.

Heidenhain's[1] observation, that wounds which had healed under congestion hyperæmia produced very soft scars, must be here mentioned.

Owing to the stubbornness of keloids, further experiments with congestion hyperæmia are desirable.

TREATMENT OF TENDO-VAGINITIS CREPITANS

I DESIRE in this edition to devote a special chapter to tendo-vaginitis crepitans, because we have had successes with hyperæmic treatment in sixty-four cases, a number considerably exceeding our previous successes, especially with regard to rapidity of cure. We have successfully employed both forms of hyperæmia, active and passive, but believe we obtained better and more rapid results with the latter. The pains and the cracking disappeared after a few days, to appear no more.

The technique requires nothing special. The patients can be treated while up and about, after the correct adjustment of the congestion bandage has been ascertained, for there are no such dangers as in acute inflammation leading to suppuration. Others, too, have emphasized the good effect of hyperæmia treatment in tendo-vaginitis crepitans.

TREATMENT OF DISEASES OF THE SKIN

I BRIEFLY refer to diseases of the skin in order to stimulate further experiments in this domain. I have treated with good success a series of skin diseases with hyperæmizing agents, some of which have been treated in vain by prominent specialists—*e.g.*, acute and chronic eczema. For the former, passive hyperæmia proved effective; for the latter, both active and passive.

[1] Heidenhain, Transactions of the Thirty-fifth Congress of the Deutsche Ges. f. Chir., vol. i., p. 237.

A stubborn acne which very much disfigured the face of a young lady disappeared under methodically practised congestion hyperæmia of the head, after previously futile experiments with suction appliances.

An exotic disease of the nail, which, in the opinion of an expert, was due to mycosis, and which had been treated in vain for a long time, rapidly improved under hot-air therapy.

Ritter found psoriasis spots disappear under hot-air treatment.

Colley[1] observed that eczema healed very well under congestion hyperæmia, and believes that the remedy will in time give fine results in this class of disease.

No specialists, as far as I know, have contributed anything in this domain.

TREATMENT OF NEURALGIAS AND OTHER PAINS BY HYPERÆMIA

In several places in this book I have plainly shown that, of all effects exercised by hyperæmia, the pain-relieving one is the most striking. It has also proved itself very effective in various painful affections without demonstrable anatomical changes, especially in neuralgias. For the latter, active hyperæmia is evidently far the better remedy. I, and many other physicians, have used it with good results in numerous cases of lumbago and sciatica and trigeminus neuralgia.

I have as a rule treated lumbago and sciatica with the pelvis hot-air box represented in Fig. 4, the patient lying on the abdomen, the apparatus placed over him, or, if the patients were helpless, with the chair-like apparatus manufactured by C. Eschbaum, described on p. 36. It is evident that in lumbago the pelvic and lumbar region must be influenced, but even in sciatica the pelvis box has generally proved more effective than the apparatus which take in the entire leg up to the hip.

Trigeminus neuralgia has been treated by us in a simple manner. We permitted hot air to stream against the

[1] Colley, "Beobachtungen und Betrachtungen über d. Behandlung akuteitriger Prozesse mit Bier'scher Stauungshyperämie" (*Münch. Med. Wochenschrift*, 1906, No. 6).

affected half of the face from the apparatus depicted in Figs. 5 and 6. Anyone who has at his disposal an electric hot-air douche after Frey or Hahn will prefer it, because the patient is not annoyed by the combustion products of the alcohol and gas.

Of late I order neuralgia of the trigeminus and of the sciatic nerve to be treated with the hot-air massage recommended by Frey.

I have succeeded in curing a series of cases of trigeminus neuralgia in which all possible remedies had been exhausted, for which reason the patients have been referred to our clinic for operation, either with hot air alone or with the still more effective hot-air massage without any operative intervention whatever. If it is desired to produce a favourable effect by heat alone, it must be applied often and very energetically, under certain circumstances disregarding a burn of the first degree.

I have also employed for trigeminus neuralgia congestion hyperæmia, which I produced by the application of a rubber bandage around the neck, but had no result with it. In two cases in which the congestion hyperæmia failed, I succeeded with active hyperæmia produced by hot air.

On the other hand, I have successfully employed congestion hyperæmia for all sorts of headache, especially anæmic headaches. It also has a favourable effect on headaches from other causes, even in that produced by suppurative or tuberculous meningitis.

I am astonished that this effect of hyperæmia has not been used to better advantage. Neu[1] alone has recently reported on it. He says : " In headaches, nervous as well as anæmic, congestion hyperæmia never left me in the lurch." I must concur with Neu, who suggests that the congestion bandage should not be drawn too tight.

[1] Neu, " Über d. Anwendung künstlich erzeugter Hyperämie des Gehirns bei Geisteskrankheiten " (*Psychiatr.-Neurol. Wochenschrift*, 1906, No. 15).

HYPERÆMIA TREATMENT OF DISEASES OF THE CENTRAL NERVOUS SYSTEM, ESPECIALLY THE BRAIN [1]

THIS chapter aims at inciting alienists and neurologists to institute experiments with the hyperæmia treatment of diseases of the central nervous system. I believe that in this branch of medicine, which is as interesting scientifically as it is defective in real curative agents, fairly good results could be obtained from artificial hyperæmia. I made a beginning a number of years ago, and refer to the contribution then published.[2]

The question is, Which form of hyperæmia should be employed in diseases of the brain? I believe that, with the present state of technique, the rubber bandage applied around the neck is the most effective. Whether Schmieden's above-described large suction apparatus can be here utilized experience must teach. Perhaps simple suction-bells applied to the top of the head could be utilized. The objection that suction apparatus cannot affect the brain through the bony cranium is, I think, untenable. I repeat what I have often emphasized, that this suction action produces hyperæmia to a great depth. However, this is yet a pure matter of experiment.

I have no experience with active hyperæmia of the brain by heat, especially by hot air. This, too, is as yet pure matter of experiment.

So far I have seen favourable results from congestion hyperæmia of the neck in chorea minor. I have treated five cases. In a few the success could not fail to be recognized. The following are my two cases which ran the most favourable course:

88. A farmer's son, seven years old, was admitted to the surgical clinic at Greifswald, April 18, 1899, for an empyæmic sinus. He was a pale, emaciated boy who had been treated elsewhere by resection of the rib. As the sinus did not close, and there remained a cavity of the size of a fist,

[1] Among the following diseases infections, too, are possibly included. Of chorea, for example, we do not know whether it represents an infectious disease.

[2] Bier, "Über d. Einfluss künstl. erzeugter Hyperämie d. Gehirns u. künstl. erzeugten Hirndrucks auf Epilepsie, Chorea u. gewisse Formen von Kopfschmerzen" (*Mitteil. aus d. Grenzgebieten*, vol. vii., Nos. 2 and 3, 1900).

the three rib segments covering the cavity were resected May 3. Operation and wound repair ran a normal course.

The boy became restless, and lost his appetite May 16, and on May 29 phenomena of chorea minor appeared. The patient made incoordinate movements with hands and feet, and "made faces." Sleep remained good. In the next few days pronounced chorea developed. June 7 the status was: The boy shows extreme restlessness. In addition to the ordinary choreic movements, he throws the entire upper body to and fro, tosses his legs about, and is totally incapable of using a limb, so that he has to be fed. The eye muscles, too, are attacked by disease. The boy scarcely sleeps during the night, and often cries out aloud. He has to be watched day and night.

No cause could be found for the outbreak of the disease; there was neither articular rheumatism nor heart trouble. The boy did not sleep at all from June 10 to 15. Bland food in few spoonful doses could be given only with the greatest difficulty. He was entirely incapable of speaking, and made vain attempts to answer questions. A babbling that could not be understood was all that came out. The boy became extremely emaciated.

In this condition a congestion bandage was applied around the boy's neck June 15, which he wore two hours morning and afternoon. It was well tolerated, and produced an intense venous hyperæmia. After this the restlessness visibly diminished, and the boy slept during the day two hours. During the night, however, the old restlessness returned, and the boy did not sleep.

The bandage has been worn lastingly since June 16. The boy slept afterwards during the day and night, with long intervals, five and a half hours. The movements became quieter, but his language had not perceptibly improved.

The disease from then improved very rapidly. Sleep, appetite, and speech returned. June 21 the boy, when he thought himself unobserved, lay almost totally quiet; he replied plainly to questions, and again used his hands.

No choreic movements occurred after June 23, when the boy lay still. The patient could himself partake of solid food, but spilled liquids on the way to the mouth. Subsequently there appeared muscular restlessness when attempting to apprehend things, and in psychic excitements—*e.g.*, change of dressings. After July 12 the disease fully disappeared.

My colleague from another department whom I called in consultation in this case declared it very grave, and thought the prognosis as to life very doubtful.

89. A boy, twelve years old, suffered in the beginning of November from a grave endocarditis. At the end of the month slight choreic movements of face and right leg appeared, which increased subsequently.

January 14, 1906, the boy came under my care at the Johannis Hospital, after having tried internal remedies without success. The patient had a pronounced chorea, essentially limited to the right side. While walking he turned the right leg with pronounced extension outwards, at the same time making throwing movements with the right arm and right hand. With the right half of the face he made grimaces. Things were similar when he rested in bed, only that the restlessness was greater and more general when the physician entered the room. The boy shot up high with his whole body, and on lying down he clumsily turned on one side. He spoke too hastily, somewhat brokenly, but plainly. In addition he showed all the signs of mitral insufficiency.

The boy could not sleep well. Sleep was restless and broken.

January 14 a congestion bandage was applied around the neck, and

worn twenty-two hours. It produced considerable hyperæmia of the head.

The patient at once slept much better. The next day the contractions had diminished in frequency and intensity. Congestion hyperæmia of twenty-two hours was continued. January 18 the choreic movements had disappeared. The boy rose the next day. There was no trace left of the disease. For the sake of safety the congestion hyperæmia was still continued. It was applied from January 19 to 26 during the night, and from then to February 2 only one hour daily. The stubborn chorea, which previously had steadily increased in intensity, was completely cured by congestion hyperæmia in three to four days.

I must admit that the other three cases did not run so favourable a course. One of them does not count, because there were only traces of chorea at the beginning of the treatment, and because I was not able to observe the course of the disease to the end. Of the two other grave cases of chorea, one came for treatment five days after the outbreak of the disease. It got completely well in thirty days by treatment with congestion hyperæmia. This, nevertheless, must be regarded as a good result, for the quieting effect of the remedy was obvious from the very beginning.

In the other case, however, congestion hyperæmia seems to have failed. This is the case of a boy whom I treated with congestion hyperæmia for the past five weeks, without his having improved any more than can be expected from rest in bed. In a case of Huntington's chorea which I have treated for some time the effect is doubtful. The parents consider the boy greatly improved; his lady teacher denies any influence (report by letter). I have also treated the following case of symptomatic chorea produced by brain tubercle, which terminated unfavourably, as was to be anticipated.

90. A daughter of a coachman, thirteen years old, was admitted April 4, 1900, for tuberculosis of the left calcaneus.

May 14 we noticed a peculiar staring look in the girl's eyes, anxiety, and restlessness during the change of dressings, at which time an involuntary bowel movement occurred. The night previous to this sleep was restless. During the night from May 14 to 15 the patient tossed herself about and slept little. May 15 a pronounced chorea appeared, restricted to the left half of the body. A congestion bandage was applied around the neck. After this the movements lessened and sleep became quieter. After May 18 contractions occurred only during the change of dressings, and sleep was normal. It was noticed that since May 7 rises of temperature appeared.

The choreic movements again appeared from May 21. The temperature rose higher, ranging between 38° and 39° C. The patient sank rapidly, and died June 13. Post-mortem showed tuberculosis of the left calcaneus, lungs, and intestine (the two latter ran their course without any signs), and numerous tubercles in the brain.

Taken all in all, I believe that our results in chorea are such that we can advise further experiments in this direction.

I have applied local congestion hyperæmia in eleven cases of epilepsy. In my contribution named above I have described ten cases. Of late I have treated an eleventh case, which has shown so decided an improvement that it has encouraged me to make new experiments, from which, of course, I do not hope too much.

91. An architect, fifty-five years old, who comes of a healthy family, suffered from diverse injuries of the head. In his profession he was repeatedly superficially wounded on the scalp by falling bricks. Once he received a violent blow with a stick over the head. In 1890 he was shot with a revolver at short range in the region of the right malar bone. The bullet was not removed; the wound healed rapidly. One and a half years later, at first during the night, epileptic spasms appeared. The patient yelled, foamed at the mouth, ground the teeth, became unconscious, and injured himself very often. The spasms occurred often, and had a tonic character. The fact of their beginning at one particular point in the body was never observed. Besides this, the patient suffered from numerous attacks of vertigo. Thus the disease dragged along with variations until the symptoms became worse six months ago. The vertigo and spasms increased, and the man frequently fell in the street. He became forgetful, neglected his business, made day-trips of which he afterwards knew nothing, was alternatingly restless and comatose, and had headache almost continuously.

He was admitted to the Johannis hospital January 16, 1906. Except for his headache, he is a wiry, healthy man. The scalp is covered with several cutaneous scars, which show nothing noteworthy. Scarcely anything is to be seen of the shot-wound in front of the ear. There are scars at the margin of the tongue. The Röntgen picture shows that the bullet is situated closely beneath the cranial capsule immediately in front of the vertebral column. Several splinters of the bullet are closer to the surface. The examination of the nervous system gave nothing notable.

January 17 the patient had several attacks of vertigo after a restless night. The following night, again several attacks of vertigo and one spasmodic attack.

As the bullet was very unfavourably situated for operative removal, surgical intervention was desisted from, especially as it would have scarcely modified the disease, even if it could have been technically successful. As an experiment I applied on the evening of January 19 a congestion bandage for three hours. The patient passed a quiet night. The bandage was worn from eight to ten hours daily from January 20 to 28, the day of his discharge. The patient had during the entire time neither headache nor spasmodic attacks, and in three days one on each, and in one day two mild attacks of vertigo, but none in five days.

Anyone who is interested in the observations which I have made regarding the employment of head-congestion in epilepsy should read them in my above-mentioned contribution in the *Grenzgebieten*. Among alienists, Neu[1] has tested

[1] Neu, "Über die Anwendung künstl. erzeugter venöser Hyperämie des Gehirns bei Geisteskrankheiten" (*Psychiatr.-Neurol. Wochenschrift*, 1906,

these experiments, but, like myself, has seen neither significant improvement nor a change for the worse.

I am, however, of the opinion that there are elsewhere cases in psychiatric clinics in which the hyperæmizing method could be applied with hope of success. I refer in the first place to conditions of nervous and psychic irritation of all kinds, and, again, to melancholia. Of course, all we could here expect would be a favourable symptomatic influence, for a real cure of a malady so deeply rooted in the constitution of the patient as the ordinary epilepsy and certain forms of melancholia can scarcely be hoped for. Seven years ago I tried in vain to personally interest well-known alienists in such experiments with head-congestion. No doubt at that time congestion hyperæmia, and especially that of the head, was looked on with mistrust or with plain derision. Neu, however, has interested himself in the matter. He confirms, as already referred to, my observations on the manifest improvement of headache by the congestion bandage.

Neu believes he observed improvement by congestion hyperæmia in melancholic conditions, but he saw no result in maniac and depressive conditions.

I remind the alienists that they have earlier applied hyperæmia unconsciously in brain diseases by their much-employed "derivative method." This applies especially to the energetic cauterization of the scalp with tartarus stibiatus ointment, a method which has been almost entirely abandoned on account of its cruelty (frequently the bones became necrotic under it). Probably the less harmful congestion bandage serves the same purpose much more simply and more efficiently.

People have tried hyperæmizing methods for sea-sickness. Several years ago a colleague told me that he tried head-congestion for it with success. Recently I have heard the same thing from an American physician. The newspapers published some time ago an account by the traveller Eugen Wolff of the use of hot compresses to the head for sea-sickness. The artist Kappmeier of Capri recommends

No. 15), and "Die Zirkulations- u. Druckverhältnisse im Gehirn nach Einleitung künstl. erzeugter Hyperämie des Kopfes" (*Neurol. Centralb'att*, 1907).

a complicated electrically heated apparatus based on the same principle.

I have no opinion as to the efficacy of this remedy for sea-sickness.

It may not be impossible to hyperæmize the spinal cord. It is highly probable that the active hyperæmia from the heating agents applied to the outer surface of the back, which in disease of the spinal column, as numerous observations have taught me, penetrates to the depth of the vertebræ, may also affect the spinal cord.

The same may hold good also for the passive hyperæmia of the suction apparatus. Years ago at least I employed it to great advantage in painful spondylitis. Lately I have resumed these experiments with better apparatus with like results. The patients uniformly assure us that the pains immediately after the application of the apparatus are either greatly lessened or disappear. Probably they, too, affect the spinal cord.

Undoubtedly we produce a transitory hyperæmia of the spinal cord, and also of the brain, by Quincke's lumbar puncture, if we remove large quantities of liquid, in the same way as the removal of an ascites produces hyperæmia of the abdominal organs, or that of the pleuritic exudate hyperæmia of the pleura and lungs.

The congestion hyperæmia of the head by a rubber bandage placed around the neck evidently acts very strongly on the lymph-current in the spinal cord and its vicinity (liquor cerebrospinalis). As I have described in the contribution mentioned above in the *Grenzgebieten*, congestion hyperæmia of the head results in a lasting increase of the flow of liquor cerebralis towards the spinal cord, producing there lasting rise of pressure.

All these things require to be thoroughly examined.

Probably in olden times the spinal cord was unconsciously hyperæmized by the favourite "derivative" remedies: ferrum candens, fontanelles, and moxæ, applied to the spinal column.

A hyperæmizing treatment of the spinal cord is applicable first of all in very recent acute poliomyelitis.

APPLICATION OF HOT AIR IN VASCULAR DISEASES

An old quarrel is centred around the question whether the dilatation of the bloodvessels following artificial bloodlessness, heat, and similar influences, is to be interpreted as a paralysis or stimulation of the nerves of the vessel or vessels.

With regard to reactive hyperæmia after artificial bloodlessness, for which the former theory was held without dispute, I have convincingly demonstrated that we have not to deal with a paralysis. By analogy I conclude that the same thing holds good also for heat effect as long as there is no burn. If we allow that the dilatation by heat is an active process, like that due to the effect of intense cold, we possess a remedy by which we can powerfully stimulate the vessels.

This is what occurs for a considerable period with a number of hydrotherapeutic procedures. I believe, however, that in this domain, too, the intensely hot air is the most effective agent. Thus, I frequently observed in circulatory disturbances after fractures the rapid disappearance, not only of the œdema, but also of the livid discoloration of the skin—in fact, much more rapidly than after any othes remedy. For this reason I have made use of the hot air especially for the

Treatment of Varices and their Sequelæ.

It seems to me that the varices improve and diminish by long-continued hot-air treatment. This method is especially indicated in the disagreeable sequelæ of the varices—*e.g.*, thrombosis.

I have never treated very recent thromboses with hot air, but have waited some time until the accompanying inflammatory signs have diminished, and until the thrombosis ceased to progress or was about to recede. Then hot-air treatment was applied one hour daily.

I caution particularly against the use of this agent in thrombosis of deeper veins—*e.g.*, the femoral vein—before the termination of six months after the appearance of coagulation. I observed that a man who had been afflicted for several months with thrombosis of the femoral vein, and

who had walked about for some time, suffering only from œdema and lividity of the extremity, suffered under hot-air treatment from embolism of the pulmonary artery, and died suddenly.

It is not impossible that the powerful circulation of the blood produced by the hot-air treatment softened the already firm thrombus and dislodged it. With the superficial cutaneous veins the danger of embolism, as has been shown by other experiences, is exceedingly small. For this reason I have never hesitated in this disease to promote the solution and resorption of developing thrombi by active hyperæmia. In older thromboses of the femoral vein hot-air treatment is an excellent remedy. I have treated a whole series of pronounced cases, and have improved them rapidly and lastingly.

In addition to the thrombi, the infiltrations, and, above all, the œdema of the skin, are very rapidly removed by the hot-air treatment. Judging from a large experience, I can recommend this method for varices and their sequelæ. In private practice I have put on their feet by its means men who have been invalids for years. Ulcers existing at the same time are no contra-indication to the treatment.

The same holds good for a peculiar and disagreeable vascular disease which is prevalent in Pomerania, leading to leg ulcers and eczema, and classified among the varicose affections. The large veins in these cases are but little dilated, but on standing there immediately appears a pronounced lividity and venous congestion hyperæmia in the skin of the leg, which in addition produce all the known phenomena preceding grave varices. Probably we have to deal with an affection of the small veins, and possibly also of the capillaries.

In these stubborn cases hot air has also rendered excellent service.

Treatment of Threatening or Pronounced Diabetic Gangrene.

In several instances of diabetic and arterio-sclerotic vascular diseases of the foot and lower leg which threatened to become gangrenous—*i.e.*, they felt cold, were livid and

œdematously swollen, and had at several places suspicious black spots—I have regularly observed recession of the threatening symptoms under the treatment by hot air, and the affected extremities again became fit for use. Naturally, in such cases the greatest care must be exercised in order to produce no burns with the low circulation. The danger is very great, because the sensibility of the skin is greatly diminished. I have always commenced with low degrees of heat, and have not exceeded 90° C. As soon as the patient experienced the least inconvenience, the temperature was at once lowered. Hot-air treatment in such cases should be given only if one supervise it oneself or can command reliable assistance. Intelligent patients soon discover the degree of heat which they can tolerate, so that further treatment can be entrusted to them. In such cases one must not neglect to secure proof of the sensibility of the skin. If it be diminished to a great extent, it is best to carefully commence with very short séances (ten minutes), increasing them but gradually to one hour.

It is noteworthy that in these pronounced vascular diseases the hot air produces intense arterial hyperæmia, in spite of impeded circulation and excretion of sweat.

I believe that in these diseases the hyperæmia acts in a twofold manner. On the one hand the rapid blood-stream dissolves the morbid granulations of the intima, and causes their resorption, and again the vessels are "exercised" by the intense stimulus of the high temperature.

At any rate, hot air is one of the best means to "exercise" pathologic and functionless vessels (a sort of gymnastic of the vessels). One need not think alone of the arteries and veins. I believe I have demonstrated in my repeatedly cited contribution on the development of the collateral circulation that in hyperæmia which is produced by dilatation of the vessels the capillaries take a prominent part.

I am of the opinion that capillary affections are more frequent, and are of greater import, than is usually acknowledged. We know of endothelium diseases of the heart, arteries, and veins. But as the endothelium of the vessels forms one connected tube which is most extensively represented in the capillaries, and is there subjected to great exertion, because it is there that the real work of the blood

begins, it is simply logical to assume that this part of the endothelial tube also is attacked by disease. I could cite observations which would show the probability of such diseases, but will omit them, as they do not belong to our subject.

I have treated two cases of diabetic and one of developed gangrene with the congestion bandage. One of the former suffered from a progressive phlegmon due to necrosis of tendons and bones of the foot. He died in diabetic coma before an opinion could be passed on the effect of the remedy. The other two cases terminated favourably. The insignificant gangrene, which in one case attacked a small toe, and in the other the skin of the heel, soon became demarcated. I have seen no bad effect from the remedy. As already mentioned, Colley[1] and Habs[2] caution against the application of the congestion bandage in diabetes. Colley treated two pronounced diabetics with the congestion bandage for gangrene. In one the least pressure of the constrictor produced gangrene of the skin; the other tolerated the bandage fairly, but the cutaneous gangrene spread rapidly.

Habs observed that a very early diabetic gangrene ran a foudroyant course after he had instituted the treatment with congestion hyperæmia.

On the other hand, Körte[3] and Rubritius[4] report favourable results obtained by them with the congestion bandage in diabetic gangrene.

As can be seen, the views on this subject are contradictory. But as physicians who had mastered the congestion hyperæmia procedure have had harmful results with it, the greatest care is certainly necessary. The congestion bandage should be employed in such cases as we chose for experiment only for one hour, frequently changing the place of constriction.

[1] Colley, "Beobachtungen u. Betrachtungen über d. Behandl. akut-eitriger Prozesse mit Bier'scher Stauungshyperämie" (*Münch. Med. Wochenschrift*, 1906, No. 6).

[2] Habs, Transactions of the Thirty-fifth Congress of the Deutsche Ges. f. Chir., vol. i., p. 220.

[3] Transactions of the Thirty-fifth Congress of the Deutsche Ges. f. Chir., vol. i., p. 220.

[4] Rubritius, "Die Behandlung akuter Entzündungen mit Stauungshyperämie" (*Beiträge z. Klin. Chir.*, vol. xlviii., No. 2).

It appears that in senile gangrene unfavourable effects from the congestion bandage have not so far been observed. Habs reports that he has employed congestion hyperæmia on many individuals suffering from arterio-sclerosis without having seen any trouble from it, and that in four cases of senile gangrene, in which the constrictor had been employed, the gangrene did not progress, but became demarcated.

Frommer[1] reports in four cases of senile gangrene good results with congestion hyperæmia. He found that with this treatment the pains rapidly disappeared, mobility of the joints returned, the ulcers became cleaner, and the necrotic parts were cast off.

THE TREATMENT OF FROST-BITES

Ritter[2] has recommended hot air for frost-bites. In his opinion, the hyperæmia after the effect of cold is not something to be avoided, but contributes to the regeneration of the cells damaged by the cold ; for in every freezing process, even of the first degree, injury and a certain necrosis of the cells takes place, as can be seen by the exfoliation of the epidermis and by microscopic observations. Ritter obtained the best results with hot air. It soon removed the well-known disagreeable subjective phenomena of frost-bite, especially the itching, and cures in a short time the chilblains and ulcers and the lividity of the affected extremities.

On account of the removal of the lividity, one would be tempted to explain the effect of hot air as arising from "vessel exercises," described in the preceding chapter. But Ritter demonstrated that the passive hyperæmia produced by bandage has also a healing effect on frost-bite. Ritter's view, therefore, that we have here to deal with a stimulation of regeneration of the injured cells, may be correct.

Ritter made his first experiments in the Greifswald

[1] Frommer, "Über die Bier'sche Stauung mit besonderer Berücksichtigung d. postoperativen Behandlung und der Altersgangrän" (*Wiener Klin. Wochenschrift*, 1906, No. 8).

[2] Ritter, "Die Behandlung d. Erfrierungen" (*Deutsche Zeitschr. f. Chir.*, vol. lviii.), and "Weitere Erfahrungen über d. Behandl. d. Erfrierungen mit künstl. Hyperämie" (*Correspondenzblatt d. Ärzte-Vereins d. Reg.- Bez. Stralsund*); and Hanusa, "Über d. Behandl. lokaler Erfrierungen mit passiver und aktiver Hyperämie."

surgical clinic, which was then under my direction. I have observed his excellent results, and can confirm the beneficial effect of the hot air from my own experience obtained later. The technique of hot-air treatment in frost-bite presents nothing special.

The hot-air treatment has been found to be of great and widespread use. In addition to the above-named affections, which primarily are of interest to the surgeon, it has been employed in gynæcology (para- and perimetritic exudates, other chronic inflammations, abdominal wall fistulæ), in skin, eye, ear, nose, and internal diseases. It would lead us too far to recite them all, as I naturally have no experience with them. I can prove, however, to my satisfaction that the effects observed principally in surgical diseases, and described by me in the General Part, have been, almost without exception, confirmed.

I have far from cited all the diseases for which we have made use of hot air (for instance, the treatment of contracted flat feet). But in order to give an example of the variety of diseases for which our remedy may be used, I cite the number of hot-air baths and hot-air douches given in *one* month in the hospitals under my direction.

They numbered in the surgical clinic and polyclinic 850, and in the Johannis hospital 271—*i.e.*, in one month over 1,100.

The majority of hot-air baths are administered in the dispensary. The value of the procedure can be judged from the great popularity it enjoys, and from the considerable number of patients coming to our clinics.

Above all, this method of cure enables the general practitioner to himself treat a number of patients whom he was in the habit of referring to medico-mechanic institutes, or who themselves sought the services of a specialist. For, as already said, the technique of the hot-air treatment and the appliances necessary for it are very simple, and whatever the zeal of specialists has made complicated is, if not superfluous, at least very unimportant. For this reason I believe that, in spite of all improvements, the simple apparatus modelled upon my original boxes will not disappear very soon from practice.

CONCLUSION

I HOPE that I have succeeded in sketching the outlines of a doctrine of the effect and application of hyperæmia on as scientific a basis as that of any other of our therapeutic methods, with the advantage of being simple and logical. It seems to me that I have presented views and observations sufficiently mature, for I have practised these methods for more than fifteen years; and as I have so far treated with hyperæmia a very large number of cases, most of my assertions are based on unusually wide observation.

I believe that the practical application of hyperæmia represents the most general method of cure which exists, for I know of no other remedy which can be successfully employed in so great a variety of diseases. I have already described in this treatise so many different diseases that it may appear to many that I have gone too far in this. I am convinced that a fuller experience will compel me to change my views, and to retract some of the things I have said and recommended. It would be wonderful if it were otherwise. On the other hand, I am under the impression that a remedy which Nature avails itself of so constantly for the removal of all possible injuries permits of still more extensive application.

Furthermore, I believe I have shown convincingly that, unconsciously, hyperæmizing remedies have been made use of for a longer time than history, and that in many old popular remedies which have been carelessly thrown overboard there is yet a good kernel.[1]

[1] "History shows that the ideas of subsequent generations again and again return to questions which earlier observers were believed to have decided."—Virchow, in his preface to "Gesammelte Abhandlungen zur wissenschaftlichen Medizin," Hamm, 1862.

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